Appendix: Water Quality

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Freshwater Vital Signs Monitoring Plan for National Parks in the Northeast Temperate Network (NETN)

PHASE I: A Scoping Report

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Administrative Report

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LIST OF ACRONYMS

ACAD	Acadia National Park
BOHA	Boston Harbor Island National Recreation Area
CFU	Fecal coliform units
GIS	Geographic Information System
FCA	Fish Consumption Advisory
LDC	Legacy Data Center
MABI	Marsh-Billings-Rockefeller National Historical Park
DEP	Department of Environmental Protection
MIMA	Minute Man National Historical Park
MORR	Morristown National Historical Park
MPN	Most probable number
NAWQA	National Water-Quality Assessment Program
NHP	National Historical Park
NHS	National Historic Site
NP	National Park
NPS	National Park Service
NRA	National Recreation Area
NETN	Northeast Temperate Network
NWI	National Wetland Inventory
NWIS	National Water Information System
PCBs	Polychlorinated Biphenyls
PRIMENet	Park Research and Intensive Monitoring of Ecosystems
ROVA	Roosevelt-Vanderbilt National Historic Site
SAGA	Saint-Gaudens National Historic Site
SAIR	Saugus Iron Works National Historic Site
SARA	Saratoga National Historical Park
STORET	U.S. Environmental Protection Agency’s storage and retrieval database
TMDL	Total Maximum Daily Load
USFWS	U.S. Fish and Wildlife Service
USEPA	U.S. Environmental Protection Agency

USGS	U.S. Geological Survey
WEFA	Weir Farm National Historic Site

EXECUTIVE SUMMARY

An inventory of freshwater resources in the Northeast Temperate Network (NETN) parks is created as a basis for the design of long-term freshwater-resources monitoring efforts. This inventory includes a description of monitoring programs related to freshwater resources and water quality in each park, descriptions of current and emerging threats for NETN ecosystems, and network-wide water-quality objectives and candidate monitoring variables. Conceptual models integrate freshwater ecosystems with potential threats at each park.

Although baseline freshwater-quality data is being collected in some NETN parks, these parks generally do not have long term data-collection programs that include systematic quality control and (or) data management. These types of data-collection programs are important in evaluating the effect of threats to freshwater ecosystems in the parks. Threats common to all parks include climate change, atmospheric deposition, visitor use, and invasive species. In addition, urban and residential development, and agriculture have the potential to degrade freshwater resources in most of the parks. Core monitoring variables that would assist in detecting ecosystem responses to these threats include alkalinity, pH, conductivity, dissolved oxygen, temperature, surface-water flow, toxic elements such as mercury, turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria.

INTRODUCTION

The Northeast Temperate Network (NETN) is made up of the following 10 National Parks (NP), National Historical Parks (NHP), National Recreation Areas (NRA), and National Historic Sites (NHS):

1. Acadia NP, Maine (ACAD)
2. Boston Harbor Island NRA, Massachusetts (BOHA)
3. Marsh-Billings-Rockefeller NHP, Vermont (MABI)
4. Minute Man NHP, Massachusetts (MIMA)
5. Morristown NHP, New Jersey (MORR)
6. Roosevelt-Vanderbilt NHS, New York (ROVA)
7. Saint-Gaudens NHS, New Hampshire (SAGA)
8. Saugus Iron Works NHS, Massachusetts (SAIR)
9. Saratoga NHP, New York (SARA)
10. Weir Farm NHS, Connecticut (WEFA)

In all NETN parks, freshwater resources are subjected to natural and anthropogenic impacts and alterations, which, in some cases, have imposed stress on these resources for many years. Current and historic threats facing aquatic ecosystems in National Park Service (NPS) units throughout the northeastern U.S. have led to specific physical, biological, or chemical stressors to the freshwater ecosystems. These stressors include organic and inorganic contaminants from agricultural practices and septic system leachate; hydrologic and hydraulic alterations, such as the installation and renovations of bridges, roads, culverts, and drainages; ground-water withdrawals; erosion from road runoff; deposition of atmospheric contaminants; encroachments by invasive and non-native species; and industrial contaminants in the watersheds.

The amount of available water-quality and water-quantity data is variable for the NETN parks. Although sparse water-quality monitoring has been done in each of the parks, no systematic water-quality and water-quantity data has been collected with adequate quality assurance over a period of record sufficient to characterize baseline conditions and evaluate spatial and temporal changes in freshwater resources throughout a park. The documentation of baseline water-quality and quantity conditions is critical to the long-term maintenance of freshwater resources in the parks. Changes in baseline conditions will assist natural resource managers in identifying and managing stressors in park freshwater ecosystems.

An Inventory and Freshwater-resources Monitoring Design Project will be conducted in three phases.

PHASE I: Produce a Scoping Report for the NETN parks.

PHASE II: Design prototype guidance for monitoring freshwater resources in the NETN parks. This includes prioritizing the list of candidate monitoring variables into a final list of variables (vital signs) that will be measured in all NETN parks.

PHASE III: Conduct feasibility (pilot) testing of recommended freshwater-quality/aquatic-resource monitoring components at select NETN parks in order to finalize the freshwater-resource-monitoring design for the network.

This report is limited to phase I, which will create a resource inventory for freshwater resources in the NETN upon which the design of long-term freshwater-resource monitoring efforts can be based. The purpose of this report is to locate and reference existing baseline data in the NETN parks, and to identify potential candidate monitoring variables that could be used to (1) characterize the condition of freshwater resources in the NETN parks (2) determine the natural range of variability in water quality in the NETN parks, and (3) establish whether the natural range of variability is changing due to anthropogenic threats. The report includes the following:

1. Description of ongoing inventory or monitoring programs related to park freshwater resources and water quality
2. Draft conceptual models of key ecosystems in the NETN parks
3. Descriptions of current and emerging threats for NETN ecosystems and relevant agents of change that could affect NETN aquatic resources
4. Description of the types of freshwater bodies present in the parks using published information such as classifications from National Wetland Inventory (NWI) and bathymetry maps
5. Summary of information from State reports to the U.S. Environmental Protection Agency (USEPA) regarding the Clean Water Act sections 305(b) and 303(d).
6. Identification of specific freshwater resources that are of unique importance on watershed or regional scales
7. Freshwater body area statistics based on GIS coverages, NWI databases, and State coverages
8. Network-wide water-quality objectives and candidate monitoring variables

METHODS AND APPROACH

Developing this scoping report required the compilation of all information regarding freshwater resources, freshwater-quality data, and the drivers, threats, and stressors operating on freshwater ecosystems in each of the 10 parks in the NETN. Drivers are defined as major, naturally occurring forces of change on freshwater ecosystems, operating both inside and outside the park boundaries. Threats are natural or anthropogenic forces of change that impose stress on ecosystems by occurring at an excessive (or deficient) level. Threats to freshwater resources in NETN parks include climate change, atmospheric deposition, development, visitor use, agriculture, invasive species, industry, and forestry. Threats are divided into those that affect water flowing into the park, those that affect freshwater in the park, or both. Stressors are the specific physical, biological, or chemical results of the threats that cause significant changes to the freshwater ecosystem, such as road runoff, leachate from septic systems, and nutrient loading. Relations between freshwater bodies and the threats and stressors to these freshwater bodies were identified, and conceptual models were developed. These models are useful to identify the relations between threats to freshwater ecosystems and ecosystem responses, and to identify measures that can be used to monitor changes in the attributes of the freshwater ecosystems. The data are compiled by park; each park summary includes descriptions of freshwater bodies, historic and current water-quality and water-quantity monitoring, water-quality and -quantity issues in the park, and current and emerging aquatic ecosystem threats.

Data Compilation

NPS natural resource managers assisted in the identification of historic and current water-quality monitoring by the NPS, as well as in identifying natural-resource partners involved in water-quality monitoring (table 1). They identified general management plans and natural-resource management plans that were helpful in identifying the freshwater resources and many of the freshwater ecosystem threats.

The USEPA maintains two data-management systems that contain water-quality information for the nation's waters: the Legacy Data Center (LDC), and Storage and Retrieval (STORET). The LDC is a static, archived database, and STORET is a current system that has been in operation since January 1, 1999. Both systems contain biological, chemical, and physical data on surface- and ground-water collected by federal, state, and local agencies, Indian tribes, volunteer groups, academic institutions, and others (U.S. Environmental Protection Agency, 2003). There is no guarantee that all data collected in the parks have been entered into the database.

The LDC was queried by the NPS in order to produce baseline water-quality data inventory and analysis reports for many of the NHSs and NHPs from 1994 to 2000. All but two of the sites in the NETN (BOHA and SAIR) have these baseline reports. Baseline reports contain locations of historical water-quality monitoring stations for each park in an area extending at least 3 miles upstream and 1 mile downstream from the park boundary (National Park Service, 1994a). Monitoring station locations that were within park boundaries were identified. In association with the Baseline Water Quality Data Inventory and Analysis Program of the NPS, some parks in the NETN (MIMA and WEFA) were found to have depauperate water-quality databases, thereby requiring Level I water-quality inventories. A Level I water-quality inventory, as defined by the NPS Inventory and Monitoring Program, includes sampling basic water-quality parameters including alkalinity, pH, conductivity, dissolved oxygen, temperature, flow, and a rapid bioassessment baseline for fish and macro invertebrates for key waterbodies within park boundaries. Optional or case-by-case parameter groups include toxic elements, turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria (National Park Service, 1997c). Key waterbodies are either those essential to the cultural, historical, or natural resources management themes of the park, or those that provide habitat for rare plants or animals. Level I water-quality inventories also identify water-quality management issues at each park and recommend appropriate long-term water-quality monitoring strategies. MIMA and WEFA had Level I surveys conducted in 1999.

Although USGS data associated with NPS water-quality monitoring were in the LDC at the time of the Baseline Data Inventory and Analysis reports, USGS data have now been removed from the LDC and will no longer be entered into STORET. USGS maintains a separate database, National Water Information System (NWIS) on the internet, in which surface-water, ground-water and water-quality data collected by the USGS are stored, and can be queried or searched (U.S. Geological Survey, 2003).

As a part of this scoping report, the STORET database and USGS NWIS database were searched for data that was more recent than that catalogued in the NPS baseline reports. Only stations that are within park boundaries were included, except where there is no USGS streamflow gaging-station within park boundaries, in which case a representative streamflow gaging-station that could be used to estimate discharge of streams and (or) rivers in the park was included. Criteria used to select the most appropriate gage include length of record, drainage area, and proximity to the park. None of the parks (except ACAD) have a continuous-record streamflow gaging-station within their boundaries (appendix 1). Tables of representative streamflow gaging-stations are presented in appendix 1 for ACAD and in appendix 2 for all other NETN parks. In parks such as SAIR, the representative gage is on the same waterbody that flows through the park and is close to park boundaries. In other cases (such as SAGA and SARA), the gage may be in a different watershed with an entirely different drainage area than any of the surface-water bodies in the park.

Water-quality standards must be established by states for all freshwater bodies according to The Clean Water Act, section 305b. Water-quality standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants as outlined on the USEPA website, http://www.epa.gov/waterscience/standards/about/. The Clean Water Act also mandates, under section 303d that states, territories, and authorized tribes list impaired and threatened waters and develop Total Maximum Daily Loads (TMDLs) for waters on this list. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water-quality standards, and an allocation of that amount to the pollutant's sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purpose designated. The calculation also must account for seasonal variation in water quality. USEPA's 305b and 303d water-quality reports were searched for freshwater bodies in the parks that were on these lists (http://www.epa.gov/waters/), and TMDLs were referenced for park waterbodies. The 305b reports of water-quality standards and the 303d lists and attainment status for each freshwater body in each park are summarized in appendix 3. There are gaps in these lists in cases where known waterbodies in the parks were not yet assessed. For example, the most recent 305b reports from New York and New Jersey were not available.

Various NPS and state Geographic Information System (GIS) data layers were used from state offices of GIS (http://www.geo-one-stop.gov/StateLinks/index.html) and the NPS Data Clearinghouse website (http://www.nps.gov/gis/data_info/clearinghouse.html) to make the park maps included in this report. Because these layers are already compiled by the NPS and the state offices of GIS, they are not included in this report. GIS layers used include park boundaries, the NWI, streams, rivers and lakes, roads, county and town boundaries. Freshwater body area statistics for the parks described in this report are listed in appendix 4.

Conceptual Model Development

Conceptual models for the parks are based on the NPS guidelines for the Inventory and Monitoring Program that were presented on the following website:

http://science.nature.nps.gov/im/monitor/index.htm, accessed on August 5, 2003. The models developed here are designed to articulate the relations among drivers, threats, ecosystem attributes (or conditions), ecological processes, and focal resources. The relations common to all NETN parks are shown in figure 1. Maps of individual parks are shown in figures 2,4,6,8,10,12,14,16,18,20; and individual park conceptual models are shown in figures 3,5,7,9,11,13,15,17,19,21. Conceptual models will be used in phases II and III of this project to prioritize vital signs and aid in the development of a monitoring plan.

IDENTIFICATION OF NETWORK-WIDE WATER-QUALITY OBJECTIVES, AND CANDIDATE MONITORING VARIABLES

Network-wide water-quality objectives were determined on the basis of the conceptual models of the individual parks. Common threats to water resources as well as freshwater aquatic ecosystem attributes will be considered as vital signs for tracking the physical and biological integrity of freshwater resources in the NETN parks.

Network-Wide Water-Quality Objectives

The goal of monitoring water quality in the NETN parks is to define the normal limits of variation in freshwater resources in the parks. Monitoring will help managers in the parks determine if changes in water-quality parameters are within natural levels of variability or are a result of anthropogenic actions, and to adjust their management appropriately. Ideally, parks would measure all water-quality parameters; however, limited resources necessitate the selection of a subset of parameters that are significant indicators of ecological conditions (vital signs). Vital signs for a park or a network are chosen on the basis of ecological threats or stressors that have been documented in or around the parks, or have the potential to threaten freshwater resources on in the park because of surrounding land uses and (or) trends.

Natural resource managers at each of the NETN parks initially prioritized potential threats through a questionnaire. Stressors resulting from these threats were defined and prioritized according to degree of influence and potential to damage the freshwater resources during phone interviews between natural resource managers in the parks and regional water-resource professionals (table 2).

Climate change, atmospheric deposition, invasive species, and visitor use are threats or potential threats identified in all NETN parks; however atmospheric deposition, visitor use, and invasive species are greater current management concerns at the parks than climate change. Nonpoint-source pollution, including sedimentation from soil erosion, is the major stressor resulting from visitor use in the parks. In all parks except BOHA, road runoff is identified as one of the primary sources of sedimentation. Development outside the park, leading to issues with septic systems, water withdrawals, lawn chemicals, wastewater treatment, road runoff, and hydrologic alterations caused by land-use conversions are issues in all parks except MABI and WEFA, which are in primarily self-contained watersheds. Agricultural runoff is identified as a concern in about half of the NETN parks including ACAD, MABI, MIMA, SAGA, SARA, and ROVA. Industry is identified as a threat at MIMA, MORR, ROVA, SAIR, SARA, and SAGA.

Water-quality objectives at NETN parks include the early identification of water-quality degradation due to any of the above listed stressors. Vital signs monitoring also will be broad enough so any new threats or stressors to the freshwater ecosystem can be identified and managed proactively.

Candidate Monitoring Variables

A set of core water-quality monitoring parameters was identified by a NPS workgroup (National Park Service, 2002). These parameters include temperature, specific conductance, pH, dissolved oxygen, and an estimate of flow/discharge for flowing waterbodies or a stage/level of non-flowing waterbodies. These parameters can be collected in the field and will be collected at all water-quality monitoring stations. Additional water-quality monitoring parameters, including turbidity, nutrients, pathogens, and metals, will be considered at each monitoring station depending on the potential threats and (or) stressors for that park, and the cost involved. Descriptions of water-quality monitoring variables can be found in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, 1998).

PARK DESCRIPTIONS

This section describes 10 parks in the NETN. Water-quality and water-quantity monitoring and research, and current (2004) and emerging threats to freshwater aquatic ecosystems are discussed.

Acadia National Park

Acadia National Park (ACAD) in downeast coastal Maine protects 47,498 acres including 30,300 acres on Mount Desert Island, 2,728 acres on Isle Au Haut, and 2,194 acres on Schoodic Peninsula. There are more than 24 streams, 14 great ponds and lakes (greater than 10 acres), and 9 smaller ponds partially or entirely within Acadia National Park (ACAD) (fig. 2) (Kahl and others, 2000). Lakes and ponds cover approximately 2,600 acres. Wetlands cover approximately 4,100 acres, of which approximately 2,600 are palustrine wetlands. Outstanding Resource Waters for ACAD include all brooks, streams, and segments of those brooks and streams that are within the boundaries of

Acadia National Park. The coastal lakes of Mount Desert also are considered Outstanding Resource Waters. Although ACAD is part of the NETN, it also has been included in the Coastal Barrier Network of the NPS because it shares many management concerns with the coastal parks. In-depth descriptions of the estuarine and marine wetlands and threats to these resources can be found in the Coastal Barrier Network Scoping report (M.J. James-Pirri, University of Rhode Island, written commun., 2003).

A water-resources management plan for ACAD was completed in April 2000 (Kahl and others, 2000). The plan outlines the majority of the water-quality and water-quantity monitoring that has been done on freshwater resources in the park and on Mount Desert Island through year 2000, and should be consulted before additional monitoring is proposed. Additionally, an ACAD water-resource program factsheet outlines research and monitoring that has been conducted by ACAD and its collaborators (Acadia National Park, 2000).

WATER-QUALITY AND WATER-QUANTITY MONITORING

ACAD freshwater monitoring program objectives are to (1) provide baseline data on water resources in the park; (2) serve as an early warning system for anthropogenic impacts and threats such as nonpoint-source pollution, acid deposition, and climate change; (3) assist in identifying potential sources of pollution; and (4) track trends (Acadia National Park, 2000). The summary of freshwater-quality monitoring at ACAD in this section is divided into lake monitoring, stream monitoring, ground-water monitoring, and wetlands monitoring.

Lake Monitoring : Lake monitoring by park staff began in the late 1970's, in cooperation with the Maine Department of Environmental Protection (DEP) to monitor change due to eutrophication and atmospheric deposition. Monitoring included secchi disk water-column transparency and surface temperature in selected lakes on Mount Desert Island. The program continues today (2004), with monitoring expanded to include measurement of a larger variety of chemical and physical parameters including pH, specific conductance, temperature and dissolved oxygen profiles, alkalinity, and color (Breen and others, 2002). Some of the lakes also have been analyzed for concentrations of chlorophyll-a, total phosphorus, light penetration, and total nitrogen.

Stream Monitoring: Two active USGS continuous-record, streamflow gaging-stations are in the park: Cadillac Brook near Bar Harbor, Maine (USGS station 01022835), and Hadlock Brook near Cedar Swamp Mountain near Northeast Harbor, Maine (USGS station 01022860). Both have been gaged from 1999 through the present (2004). All other stream discharge measurements were one-time measurements or estimates related to specific projects (Kahl and others, 2000).

Water-quality parameters including benthic macroinvertebrates, habitat characterization, stream temperature, pH, dissolved oxygen, specific conductance, color, and flow rate have been measured since 1997 on Duck Brook, Stanley Brook, Canon Brook, and Hunters Brook, and since 1998 on Lurvey Spring Brook and Heath Brook (Breen and others, 2001). This monitoring has been conducted by park staff in cooperation with the Maine DEP. This water-quality information provides baseline information on numbers and diversity of macroinvertebrates in six ACAD streams, representing a range of sizes and levels of anthropogenic impacts.

Ground-Water Monitoring: The USGS, in cooperation with ACAD, installed four ground-water wells in 2003 to monitor water levels and water quality. Two are near

Southwest Harbor, and two are near Bar Harbor (USGS well numbers 441516068194101, 441650068210801, 442238068154101, and 442450068175201, respectively). Three of these wells are within park boundaries.

Wetlands Monitoring: Development of a freshwater wetland monitoring protocol for Acadia National Park was proposed in 2003 (H. Neckles and G. Guntenspergen, U.S. Geological Survey, oral commun., 2003). The freshwater wetland monitoring protocol project will produce an operational wetland monitoring protocol for ACAD by 2006, and provide a model that can be used in other NETN parks.

Water-Quality and Water-Quantity Research

A summary of freshwater-quality research projects through 2000 is presented in Acadia's Water Resources Management Plan (Kahl and others, 2000). The plan summarizes hydrological, chemical, and biological projects conducted on streams, lakes, and ground water in ACAD. The following summary primarily documents water-quality research that has been conducted since that time and is divided into research related to lakes, streams, ground water, wetlands, and other.

Lake Research: In 1995 and 1998, a comprehensive assessment of the chemistry of more than 24 lakes in ACAD was conducted. The sampling complemented work done in 1982-1984 by Kahl and others (1985), and provided the post-Clean Air Act Amendments status for the lakes sampled during the early 1980s, a period of high atmospheric deposition.

Stream Research: Hydrologic data, including continuous streamflow and water chemistry, collected in 14 small watersheds on Mount Desert Island was recently published by the USGS (Nielsen and others, 2002). These data include nutrients, major ions, some metals, and basic water-quality parameters including dissolved oxygen, temperature, and pH from 1999 to 2001. A water budget for and nitrogen loads to Northeast Creek has been recently published (Nielsen, 2002b).

Stream-related research at the park that is being conducted by ACAD in collaboration with the George J.Mitchell Research Center at the University of Maine includes the following topics: (1) a sampling of Hadlock and Cadillac Brook 1998-02, inferring regional patterns and responses in nitrogen and mercury biogeochemistry using paired-watersheds; (2) correlating predictive contaminant deposition maps with streamwater chemistry at Acadia National Park including the monitoring of Hadlock and Cadillac Brook and developing an atmospheric deposition model for 2002-2005; (3) correlating predictive contaminant deposition maps with streamwater chemistry at ACAD; and (4) the impact of vehicle traffic on water quality in ACAD.

In addition, in 1999 and 2000, 44 stream sites at Acadia National Park were sampled for major-ions and total mercury concentrations to determine whether mercury concentrations were related to watershed conditions, including the fire of 1947, and relative discharge. The project provides baseline mercury data for the Park and general water chemistry for sites that had been sampled in the early 1980s (Peckenham and others, 2004).

Ground-water Research: In a recent USGS publication, Nielsen (2002a) estimated the quantity of water in fractured bedrock units on Mount Desert Island, and provided an estimate of ground-water use and recharge and dilution of nitrogen in septic waste in Bar Harbor. The four ground-water wells installed in 2003 (see ground-water monitoring section) will provide data necessary for ground-water hydrology projects in the park including a ground-water degradation project to examine the significance of ground-water related nutrient enrichment to Bass Harbor and Northeast Creek, and a ground-water wetlands project to examine the hydrologic relations between freshwater wetlands and the underlying ground-water-flow systems.

Wetlands Research: A comprehensive study to describe the size and distribution of the freshwater wetlands at ACAD included information about wetland soils, hydrology, vegetation, fauna, and ecological and cultural value (Calhoun and others, 1994). Current freshwater wetland-related research projects being conducted in collaboration with the USGS at Acadia include a project developing indicators of freshwater wetland integrity (G. Guntерspergen and H. Neckles, U.S. Geological Survey, oral commun., 2003), and a project to determine wetland susceptibility to hydrologic stresses at ACAD (M.G. Nielsen, U.S. Geological Survey, oral commun., 2003).

Other: Park Research and Intensive Monitoring of Ecosystems (PRIMENet) is a cooperative program between the USEPA and the NPS to assess the ecological effects of atmospheric deposition of nitrogen and mercury in watersheds. The program includes the sampling of Hadlock and Cadillac Brooks from 1998 to 2000 at ACAD for mercury and nitrogen, and involves air-quality monitoring of ozone, wet and dry deposition, visibility, meteorology, and Ultraviolet-B (UVB) monitoring to assess the potential impacts of UVB on amphibian populations (Acadia National Park, 2000).

Geographic Information System (GIS) Applications : ArcView databases at ACAD include shoreline, lakes, streams, watersheds, soils, vegetation, land use/ownership, wetlands, topography, roads, and trails for park lands and surrounding environs. A watershed atlas is being developed to link water quality and spatial data and allow analysis of the effects of watershed characteristics on water quality.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

Acadia's ponds are generally oligotrophic (nutrient poor) and low in alkalinity. There are a few examples of lakes with acidification due to atmospheric deposition and (or) organic matter (Kahl and others, 2000). High levels of mercury are an issue in many lakes and streams. All freshwaters are listed as impaired by the state due to the presence of elevated mercury levels in fish tissue from atmospheric deposition. An additional concern in many wetland systems is the occurrence of amphibian diseases.

Ground water is generally of sufficient quantity and quality for domestic use, although increased development could affect the sustainability of water quantity and the level of water quality due to increased nitrogen/nitrate concentrations in the future (Nielsen, 2002a). High concentrations of radon-222 in the ground water, although naturally occurring, are a potential human health issue.

Additional water-resources issues of concern to ACAD park management include water-quality impacts of development, visitor use and boat discharges, hazardous waste spills, fisheries management including impacts of non-native fish on the integrity of native aquatic ecosystems, and the management and protection of wetlands and riparian zones.

Boston Harbor Islands National Recreation Area

Boston Harbor Islands National Recreation Area (BOHA) includes 34 islands that lie within the large "C" shape of Boston Harbor. The land mass of the park totals approximately 1,600 acres. Although BOHA is part of the NETN, it also has been included in the Coastal Barrier Network because it shares many management concerns with the coastal parks. In-depth descriptions of the estuarine and marine wetlands and threats to these resources can be found in the Coastal Barrier Network Scoping report (M.J. James-Pirri, University of Rhode Island, written commun., 2003). Maps and conceptual models for BOHA are not included in this scoping report.

A total of 1,276 acres of wetlands were inventoried for BOHA (Tiner and others, 2003). These wetlands are dominated by marine and estuarine intertidal types, which are predominately non-vegetated unconsolidated shores (i.e., tidal flats). In addition to the tidal flats, 82 acres of estuarine vegetated wetlands (i.e., salt/brackish marshes), 87 acres of intertidal blue mussel reefs, and 31 acres of freshwater wetlands were inventoried. Most of the freshwater wetlands are small ponds. The BOHA wetlands perform numerous functions including surface-water detention, sediment retention, coastal storm surge detention and shoreline stabilization, fish and shellfish habitat, and waterfowl and waterbird habitat (Tiner and others, 2003).

Palustrine (Freshwater) Wetlands: Palustrine wetlands occur in areas where the salinity, due to ocean-derived salts, is less than 0.5 parts per thousand (Cowardin and others, 1979). Within the national park recreation area, these are limited to a few small areas of freshwater marsh and (or) small ponds on Deer Island, Thompson Island, World's End, Long Island, Lovells Island, and Great Brewster Island (Tiner and others, 2003). Although small in area, these freshwater resources may be of significant biological value. For example, Ice Pond, a small, shallow pond at World's End is the only surface freshwater source on the island.

Ground-water Resources: In 1996, the USGS conducted a geohydrologic investigation to assess the potential for water-supply development for six of the Boston Harbor islands including Bumpkin, Gallops, Georges, Grape, Lovell, and Peddocks Islands (Masterson and others, 1996). The primary purpose of the investigation was to assess the possibility of developing permanent, small-capacity water supplies capable of supporting recreational activities such as hiking, camping, and swimming.

Masterson and others (1996) found that the hydrology of each of the six islands studied was characterized by hydraulically independent freshwater-flow systems that occur in about 10 to 30 feet of weathered till with a dense substratum near the land surface that may perch water. The freshwater-flow systems of each island is underlain by either impermeable bedrock or bedrock containing saltwater, and they also are laterally separated from one another by the saline waters of Boston Harbor (Masterson and others, 1996). Thus, the sole source of freshwater to each of the islands studied is the infiltration of precipitation into the soils of the island.

The amount of precipitation that reaches the saturated zone (recharge) would be expected to vary spatially and temporally in response to climatic factors, such as precipitation, and biologic factors such as evapotranspiration, as well as to the local topography. The recharge rates also would be affected by local differences in the infiltration capacity and other hydraulic properties in the unsaturated zone. Using estimates of recharge rates from previous investigations in similar hydrogeologic settings, Masterson and others (1996) were able to model approximate ground-water flow for the six islands.

Masterson and others (1996) determined that ground-water flow generally is radial from the center of the island towards the coast. Topographically high areas, such as the upper slopes and crests, are typically the recharge areas with downward vertical gradients. Ground-water discharge would typically occur at the lower slope areas of the drumlins, the topographically low areas, such as coastal marshes or ponds, or directly along the coast (Masterson and others, 1996).

Water-Quality and Water-Quantity Monitoring and Research

The U.S. Fish and Wildlife Service (USFWS) NWI Program conducted a comprehensive survey of all coastal, brackish, and freshwater wetlands in the park. Wetland habitats were delineated and mapped on the basis of the national vegetation classification system (Cowardin and others, 1979).

The NPS Water Resources Division identified and analyzed major water-resource issues and management concerns, summarized existing hydrologic information, and developed management recommendations for the Harbor Islands. The work includes water-related environments (ponds, salt marshes, freshwater marshes, tidal flats and pools, and ground water) and water-related infrastructure issues, which occur at or above mean low water level for all 34 islands. The 2-year project was completed in 2002. The report was accepted and the recommendations endorsed by unanimous vote of the Boston Harbor Islands Partnership on December 17, 2002 (Flora, 2002).

Currently (2004), no freshwater-quality monitoring is being conducted in the park. The Massachusetts Water Resource Authority continues its saltwater monitoring of chemical, physical, and biological parameters in Boston Harbor as a part of the regulatory compliance for its new discharge outfall diffuser. The Coastal Barrier scoping report summarizes this monitoring program in Boston Harbor and the environs (M.J. James-Pirri, University of Rhode Island, written commun., 2003).

GIS wetland data are available for BOHA from the NWI. In 2001, the NPS provided funds to the USFWS to update the NWI maps of BOHA based on the most current available aerial photography, which was 1995 color infrared at 1:40,000 (Tiner and others, 2003). These GIS maps were completed in 2003 and will soon be available via the NWI website (Tiner and others, 2003).

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

Concerns regarding freshwater resources on the islands were identified at a scoping workshop in 2000 (Flora, 2002). The most important freshwater-quality concern identified at this workshop was a lack of baseline information for ponds and freshwater marshes. The major water quantity concern was the lack of adequate freshwater drinking supplies on most of the islands. Infrastructural impacts due to septic systems and sewage disposal are a potential aquatic ecosystem threat (Flora, 2002). Due to the relatively small amount of fresh surface-water resources on the islands, and the logistical problems with monitoring them, there is no immediate plan to initiate freshwater resources monitoring in BOHA. Saltwater resources are the highest priority in BOHA, and thus maps and conceptual models for the islands are not included in this scoping report, but are included in the Coastal Barrier scoping report (M.J. James-Pirri, University of Rhode Island, written commun., 2003).

Marsh-Billings-Rockefeller National Historical Park

MABI was created in 1992 and encompasses 643 acres in the Connecticut River watershed in central Vermont, including 550 acres of forest. Freshwater bodies in the park consist of a pond (The Pogue) formed by an earthen dam, a perennial stream (Pogue Hole Brook), many intermittent streams, four wetlands, and several seeps (Lautzenheiser, 2002) (fig.4). The Pogue is a 15-acre pond, near the summit of the park that receives water from rainfall and two intermittent streams that flow off the West Ridge near the Pogue's southwestern boundary. Pogue Hole Brook flows eastward out of the Pogue and empties into Barnard Brook outside of the park, which in turn empties into the Ottauquechee River. The Ottauquechee River flows along the eastern boundary of the park and eventually flows into the Connecticut River. Barnard Brook flows close to the northeastern boundary of the park, but is entirely outside the park. Four wetlands east of the Pogue are formed by runoff and ground-water seeps that intermittently drain into Pogue Hole Brook. Additional intermittent streams drain the northern slope of Mt. Tom (Lautzenheiser, 2002).

Water-Quality and Water-Quantity Monitoring and Research

Seven stations were inside the park boundaries during the Baseline Water-Quality Inventory and Analysis conducted in 1997 for MABI (National Park Service, 1997a). None of these stations was considered long-term, (defined as having at least 6 parameters with 1 or more measurement per year over at least 2 years [National Park Service, 1997a]). Four of the stations were established in 1994 by the Water Resources Division of the NPS and had one measurement each of concentrations of total nitrogen, nitrite, fecal coliform bacteria, and phosphorus. The four locations were the Watering Trough, Pogue Hole Brook leaving the cow pasture (identified in the report as the unnamed creek leaving the cow pasture), Pogue Hole Brook entering the cow pasture (identified as the unnamed creek entering the cow pasture), and the Pogue shoreline. Eleven water-quality parameters were measured at an additional Park Service station at an unnamed spring once in 1977. The USEPA measured concentrations of chloride and chlorine in the summer of 1984 at one station on the Ottauquechee River, and measured a number of water-quality parameters at one station on the Pogue on a single day in 1984.

Currently (2004) no water-quality monitoring is being conducted in the park (C. Marts, National Park Service, oral commun., 2003). The closest streamflow gaging-station is on the Ottauquechee River at North Hartland, Vermont (USGS station 01151500). It has a drainage area of 221 square miles, and a period of daily discharge record from 1930 to the present.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

MABI is mostly a headwater watershed. Intermittent headwater streams initiate in the park and drain the park (fig. 5). For this reason, no major surface-water ecosystem threats come from outside the park. Potential stressors that could adversely affect water quality in the park include forestry in the park, runoff from visitor use, and *E.coli* bacteria, due to livestock, in Pogue stream. Although no livestock were grazing in the park in 2002 and 2003, they potentially will be grazing in the park in the future. A fence has been constructed so that any future grazing will be outside the channel of the stream (C. Marts, National Park Service, oral commun., 2003).

Although all rivers and lakes in Vermont are on the USEPA's 303(d) list for fish consumption advisory (FCA) because of mercury, neither Pogue Pond nor Pogue Hole Brook are specifically listed on either the 305(b) or 303(d) list for the state.

Minute Man National Historical Park

MIMA is approximately 15 miles northwest of Boston, Massachusetts. It contains 967 acres distributed in three parcels. The North Bridge Unit contains approximately 112 acres, the Wayside Unit contains approximately 6 acres, and the Battle Road Unit contains approximately 849 acres (National Park Service, 2003a). The Concord River flows through the North Bridge Unit. Route 2A traverses the Wayside and Battle Road Units. The park is bordered by Hanscom Civilian Air Field and Air Force Base, privately held land, and a number of public and conservation lands.

The park supports a variety of habitats. Forest is the dominant land cover, covering approximately 500 acres of the park, including about 200 acres of forested wetland. Non-forested wetlands, including several ponds, cover approximately 180 acres. Meadows and fields cover an additional 250 acres, including approximately 100 acres farmed under the park's agricultural leasing program. Shrub land also is present at the park, particularly at the interface of fields and forests. Developed areas including roads, parking lots, and buildings cover the remainder of the park (National Park Service, 2003a).

MIMA includes numerous waterbodies including sections of the Concord River, Elm Brook, Mill Brook, several ponds, and approximately 200 acres of wetlands (fig. 6). The park supports several types of wetlands, including forested wetlands, seasonal ponds, swamps, bogs, and emergent wetlands.

Water-Quality and Water-Quantity Monitoring and Research

The Baseline Water-Quality Data Inventory and Analysis (National Park Service, 1996) does not include any water-quality or quantity monitoring sites in the park. For this reason, a level I water-quality inventory was conducted in 1999 by the NPS (Farris and Chapman, 2000a).

A nutrient TMDL evaluation was conducted from June 2001 through September 2002 on the Concord River (ENSR, 2003). Measurements of the hydrology, water quality, and aquatic biology of the Concord River were conducted in 12 surveys. Although no sites were inside the park boundaries, one site was in Concord, just outside the boundary.

A rapid bioassessment using macroinvertebrates was conducted at Mill Brook in Concord in 1996 (Art Johnson, Maine Department of Environmental Protection, oral commun., 2003). The Organization for the Assabet River has monitored water quality since 1992 on the Assabet River in the lower reach, just upstream from the confluence with the Sudbury River (where it becomes the Concord River) below Dakins Brook. See http://www.assabetriver.org/wq/ for data and annual reports.

No water-quality or quantity monitoring is currently (2004) taking place inside the park (Chris Davis, National Park Service, oral commun., 2003). There is a USGS streamflow gaging-station on the Concord River below River Meadow Road at Lowell, Massachusetts (USGS station 01099500), which is downstream from the park. Its drainage area is 400 square miles, and its period of record is 1936 to the current year. Low flows are regulated by dams associated with upstream mills.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

Stressors affecting water quality at the park include road runoff, agricultural practices, residential developments, and industrial deposition of heavy metals (fig. 7). Leachate from septic systems both inside and outside the park pose a threat to water quality. There are Superfund sites upstream from the Concord River (North Bridge Unit) on the Assabet and Sudbury Rivers (Chris Davis, National Park Service, oral commun., 2003).

Nutrient loading due to industrial and residential development, including septic systems, municipal waste, and lawn chemicals is the main water-quality issue in the park according to the Level I survey (Farris and Chapman, 2000a). Agricultural and industrial runoff also are concerns.

The Baseline Water-Quality Data Inventory and Analysis showed that sites outside the park boundaries on the Concord River and its tributaries occasionally exceed USEPA water-quality criteria for dissolved oxygen, pH, and dissolved copper. Total coliform and fecal coliform concentrations exceeded screening limits for freshwater bathing (National Park Service, 1996). The results of the TMDL investigation indicate that the Concord River is eutrophic. It receives enough phosphorus and nitrogen to support the growth of aquatic vegetation at a level that impairs water quality and designated uses (ENSR, 2003).

The Concord River is listed on Massachusetts' State 303(d) List from the confluence of the Assabet and Sudbury Rivers to Billerica, which includes the section of the river that flows through the park's North Bridge Unit. Pollutants of concern noted on the 303(d) list are metals, nutrients, and pathogens (National Park Service, 2003b). Elm Brook is on the 305(b) list, with nutrients, pathogens and turbidity listed as impairments. All rivers and lakes in the state are on the 303(d) list for Fish Consumption Advisory (FCA) mercury.

Morristown National Historical Park

Morristown National Historical Park (MORR) is 30 miles west of New York City. It contains approximately 1,711 acres and is made up of four separate units. The Jockey

Hollow Unit is 1,320 acres, the New Jersey Brigade Unit is 321 acres, the Washington's Headquarter Area is 10 acres, and the Fort Nonsense Area is 35 acres. Significant waterbodies in MORR include parts of the East and West Branches of Primrose Brook and Jersey Brook in the Jockey Hollow Unit, and parts of the Upper Passaic River and Indian Grave Brook in the New Jersey Brigade Units (fig.8). The Washington Headquarters area and Fort Nonsense Area are not shown on figures 8.

Although most of the springs that contribute water to Primrose Brook surface in the park near Sugar Loaf and Mount Kemble, the source spring of the East Branch Primrose Brook is in an area known as Military Hill, on private land just outside the northeastern boundary of the park. The 0.25-mile-long headwaters of Jersey Brook, a tributary of Primrose Brook, originate from springs in the southwestern part of the Jockey Hollow Unit. The Upper Passaic River is impounded at Leddell's Pond about 1 mile before it passes through this unit (National Park Service, 2003c).

The Jockey Hollow Unit and the New Jersey Brigade Unit are in the upper reaches of the 55.6-square miles Great Swamp watershed, a subunit of the Upper Passaic River Basin. The park includes major tributaries to the Great Swamp National Wildlife Refuge and important sources of drinking-water supply for the region. Passaic River and Primrose Brook are designated as waters of statewide importance and ecologically linked to the Great Swamp National Wildlife Refuge, and other parts of the Upper Passaic River watershed (National Park Service, 2003c).

A small artificial pond, Cat Swamp Pond, and two small marshes also are in the upper Primrose Brook drainage. Cat Swamp Pond is a remnant of the water collection and storage system that was built as part of the Morristown Aqueduct Water System. The pond is surrounded by a construction berm and has no natural surface-water drainage. Its water level is maintained by the water table. Although the pond has no natural surface-water outlet, it is connected to East Branch Primrose Brook by an overflow outlet pipe along the eastern edge of the berm. Another small marsh is found adjacent to Indian Grave Brook in the New Jersey Brigade unit.

Many small wetland and riparian areas in the park are associated with streams and minor tributaries and make up approximately 64 acres based on indicator plants such as skunk cabbage. The most extensive riparian areas in the Jockey Hollow Unit border Primrose Brook. Wetland and riparian areas are found along the flood plain of Indian Grave Brook in the New Jersey Brigade unit. A small forested wetland lies at the intersection of Indian Grave Brook and a small feeder stream that runs southwest from Patriots Path.

Aquifers provide the primary water supply to many of the communities around the park. The Precambrian gneiss that underlies the park is fairly impermeable to water but does contain ground water in scattered locations. Park visitor facilities, administrative buildings, and seven park residences rely on drilled wells for water supply. Both the Jockey Hollow and New Jersey Brigade Units contain numerous natural springs and seeps emanating from a shallow aquifer (Mele and Mele, 1983).

Water-Quality and Water-Quantity Monitoring and Research

A water resources scoping report was completed by MORR in 1993 (National Park Service, 1993). The report summarizes water resources in the park, monitoring that has been completed, and proposed water-resource-related monitoring. Furthermore, an aquatic biologist with the NPS is in the process of evaluating all water-quality data in the park (Jeff Runde, National Park Service, oral commun., 2003). These sources should be consulted before any water-quality monitoring plans are initiated.

The results of the retrievals for the MORR study area from the Baseline Water-Quality Data Inventory and Analysis include four industrial/municipal dischargers, no drinking water intakes, one USGS gaging station, and 787 observations for 64 separate water-quality parameters collected by 4 federal and state government agencies at 6 water-quality stations (National Park Service, 1994a). No stations were within the park boundary. Data entered into STORET in 2004, however, include data from 9-11 stations inside the park since 1998. Most of the sampling stations represent either one-time or intensive single-year sampling efforts by the collecting agencies. One station 500 feet downstream from the outlet of Pocahontas Lake (NPS Station MORR 0006) has long-term records consisting of multiple observations for several important water-quality parameters. STORET data exist for all Level I parameter groups in the study area except for the USEPA priority toxic pollutants. Limited data were retrieved for most of the required chemical parameters.

Mele and Mele (1983) conducted quarterly monitoring of fecal coliform bacteria at five stream locations from the fall of 1982 through the fall of 1983. Selected physical, chemical and biological characteristics of the five major stream systems in MORR were monitored quarterly from the summer of 1986 through the summer of 1987 (Trama and Galloway, 1988).

A 1992 water-quality inventory, Macroinvertebrate Sampling Study (United States Department of Agriculture, 1992), with one sampling site for Primrose Brook near the park boundary was conducted by the U.S. Department of Agriculture Natural Resources Conservation Service.

The Great Swamp Watershed Association completed a watershed management plan with several water-quality monitoring sites measured downstream from the park in the Great Brook, Primrose Brook, and Passaic River watersheds. Water-quality parameters were measured between 1999 and 2001.

A section of the Passaic River that runs through the New Jersey Brigade Unit is the only part of the park lying within a 100-year flood plain (National Park Service, 2003c).

Currently (2004), the park monitors key water-quality parameters including temperature, pH, conductivity, and salinity; and concentrations of dissolved oxygen, chloride, total dissolved solids, and fecal coliform on a monthly basis at 11 stations. The confluence of the East and West Branches of Primrose Brook is used as a water-quality monitoring site by several state and federal agencies including the USFWS and USGS. The State of New Jersey, Department of Environmental Protection, Division of Watershed Monitoring, conducts macroinvertebrate sampling on the West Branch of Primrose Brook near the Trail Center parking lot (National Park Service, 2003c). Dr. Lee Pollock, of Drew University, is studying the number and variety of macroinvertebrates, as indicators of the water quality of a stream. Dr. Neil Borman, of the College of St. Elizabeth, is measuring bacterial concentrations along Loantaka Brook, including Kitchell Pond.

The USFWS initiated a program in 1991 to monitor 15 physical, chemical, and biological parameters at 16 sites in the Great Swamp Watershed (Chalmers and Skutnik, 1997). One site (FWS station ID 165) is on Primrose Brook (NPS Station E-1) in the park. This is an excellent baseline water-quality site because it is relatively unimpacted and represents natural conditions.

The New Jersey Department of Environmental Protection and Energy initiated a Level II Rapid Bioassessment Program throughout New Jersey including several sites along the Upper Passaic River, Indian Grave Brook, and Primrose Brook (National Park Service, 1993). Furthermore, the state of New Jersey Ambient Stream Water-Quality Network conducted bacterial monitoring at 1 site on Primrose Brook.

A USGS gage (station 01378690) on the Passaic River near Bernardsville, New Jersey, just downstream from the park has historical flow record, but is not currently in operation. It had a drainage area of 8.83 square miles and was gaged from 1965-1971. Two stage-gages were installed at the confluence of the East and West Branch of Primrose Brook in 2003 (USGS station 01378775 and USGS station 01378778). The closest continuous-record streamflow gaging-station is on the Passaic River near Millington, New Jersey (USGS station 01379000) with a drainage area of 55.4 square miles.

The USGS has installed a National Water-Quality Assessment (NAWQA) site to assess surface water and groundwater in the region of New Jersey that includes MORR.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

Fecal coliform is a considerable ecosystem threat in the park (Robert Masson, National Park Service, oral commun., 2003). Development just outside the park, including the construction of townhouses, is a concern to Park Service staff. A part of the park also is downstream from a Girl Scout camp on the Passaic River. Additional sources of nonpoint-source pollution include highway runoff (total suspended solids, heavy metals, hydrocarbons, and road salts); application of fertilizers, pesticides, and lime to lawns, gardens and golf courses; septic system leachate from visitor facilities, administrative buildings, and employee residences in the park; new and existing development surrounding the park; and leaking underground petroleum-storage tanks (fig. 9).

The results of the MORR water-quality criteria screen for the baseline water-quality report completed in 1994 (National Park Service, 1994a) found three parameters that exceeded screening criteria at least once in the study area. The pH exceeded the USEPA criteria for the protection of aquatic life. Indicator bacteria (total coliform and fecal coliform) concentrations exceeded NPS Water Resources Division screening limits for primary body-contact recreation.

The pH was measured 35 times at 5 monitoring stations in the study area (but outside the park boundary) from 1965 through 1980. Two observations were outside the pH range of 6.5 to 9.0 (USEPA criteria for freshwater aquatic life). PH measured inside the park from 1998 to the present had only 1 measurement outside the USEPA criteria. Total coliform and fecal coliform concentrations were determined 23 and 22 times, respectively, at 3 monitoring stations from 1969 through 1980. Twelve observations exceeded the 1,000 most probable number/ colony forming units (MPN/CFU) per 100 mL total coliform criteria, and the 200 MPN/CFU per 100 mL fecal coliform criteria. The criteria were exceeded at three stations in Indian Grave Brook and the Whippany River (MORR 0002, MORR 0005, MORR 0006).

Based on the few data inventories and analyses contained in the baseline report, surface waters in the MORR study area generally appear to be of good quality, with some indications of effects from development. Results indicate that the streams in the park generally show very good to excellent water quality, and are well-oxygenated at all times, neutral in pH, low to moderate in alkalinity, and contain low to moderate nutrient concentrations. Concentrations of total suspended solids, total dissolved solids, and chloride, and specific conductance were relatively low in all streams, but were slightly higher in Jersey Brook, Indian Grave Brook, and the Passaic River than they were in Primrose Brook (Trama and Galloway, 1988). Increases in these parameters may be associated with the proximity of Tempe Wick Road to Jersey Brook and the low-density residential development in the uppermost reaches of the Upper Passaic and Indian Grave Brook subwatersheds.

Fecal coliform bacteria levels in some locations in the park exceed standards determined by the State of New Jersey Ground-water and Safe Drinking Regulations. (Trama and Galloway, 1988). In the early 1990s, the park closed a public potable water source at the Pennsylvania Line parking lot due to continual high levels of fecal coliform. The source of bacteria found in the water samples of this study was determined to be fecal matter from warm-blooded animals. The park does not have any untreated public drinking sources, and there are no official areas for swimming.

Trama and Galloway (1988) reported very low concentrations of total recoverable aluminum in the stream water that would not pose a threat to aquatic life. Further analysis revealed high aluminum content in local soils. Although it is unlikely that the aluminum poses a threat to aquatic organisms, aluminum from the soil, if mobilized, could affect both water quality and aquatic biota. The water in Cat Swamp Pond is tannin-stained and has a heavy influx of leaf litter and a negligible rate of water exchange.

The New Jersey Surface Water-Quality Standards (as amended, May 1998) designate all surface waters of the park as trout production freshwaters. None of the waterbodies flowing through the park are on USEPA's 305(b) or 303(d) lists for the state.

Primrose Brook and the section of the Passaic River that flows through the park are also recognized by the state of New Jersey as Category One "Antidegradation" Waters. One of the highest-quality streams in the Great Swamp watershed, Primrose Brook, is the least human-influenced stream in the park (Trama and Galloway, 1988).

The good water quality generally found in the streams flowing through the park can be attributed largely to the upper watershed location of the Jockey Hollow and New Jersey Brigade Units. No permitted National Pollutant Discharge Elimination System discharges are known to occur into any of the streams upstream from the park.

Roosevelt-Vanderbilt National Historic Site

NPS sites in Hyde Park, New York, include the Home of Franklin D. Roosevelt, the Vanderbilt Mansion, and Eleanor Roosevelt National Historic Site (also referred to as Val-Kill). Collectively, these are called Roosevelt-Vanderbilt National Historic Site (ROVA) and total 682 acres. Both the Home of Franklin D. Roosevelt and Vanderbilt Mansion National Historic Sites border the Hudson River. The river is tidal from the coast to a dam at Troy, New York, 75 miles to the north. The estuary provides a marine influence far inland, resulting in unique plant communities and animal species.

The aquatic resources of ROVA consist of 4.35 miles of streams, 14 acres of permanent ponds, 40 acres of non-tidal wetlands, and numerous small, unmapped vernal pools and intermittent streams. Major rivers in the park include Fall Kill in the Eleanor Roosevelt NHS, Crum Elbow Creek in the Vanderbilt Mansion NHS, and Meriches

(Maritje) Kill in the Franklin D. Roosevelt NHS (fig.10). A 25-acre tidal marsh lies between the Home of Franklin D. Roosevelt NHS and the Hudson River (National Park Service, 2003d).

The Fall Kill, the major stream at the Eleanor Roosevelt NHS, flows from north to south through Hyde Park. The damming of Fall-Kill Creek by the Roosevelt family in 1925 created a 7-acre wetlands complex at Eleanor Roosevelt NHS. This pond/wetland area has silt deposits of as much as 4 ft (Pandullo-Quirk Associates, 1979). A series of permanent and seasonal woodland ponds occur on the site, as well as mature second-growth hardwood forest, numerous rock outcrops, a sphagnum swamp, and a wet sedge meadow. The streams at Val-Kill are low gradient.

The New York Department of Environmental Conservation is the agency responsible for protecting and regulating water resources in New York state. Under state law, waterbodies must meet specific water-quality criteria based on their rating in a classification system. All waters in the park are classified as Class C (suitable for fish propagation and fishing) or Class D (suitable for fishing). At present, all park streams currently rated Class D have been proposed for upgrading to Class C (National Park Service, 2003d).

Water-Quality and Water-Quantity Monitoring and Research

The park initiated a water-quality monitoring program in 1994. Basic data such as temperature, pH, dissolved oxygen, salinity, and conductivity are being collected at all three units on a monthly basis. Data on additional parameters, including concentrations of chloride, phosphate, and nitrate, and measurements of turbidity and alkalinity, are being collected quarterly. Starting in 1998, this work has been contracted to a laboratory (National Park Service, 2003d).

The Baseline Water-Quality Data Inventory and Analysis search of ROVA (National Park Service, 1995a) resulted in information on 11 water-quality stations within the three units that make up the park; all were NPS monitoring stations. Eight of these stations were at the Eleanor Roosevelt NHS. Six of the eight stations are on Fall Kill, a tributary of the Hudson River; one is on a pond of Fall Kill, and one is on a wetland near the park caretaker's house. Five of these stations (including the pond and the wetland) were sampled seven times in 1978-1979, and the remaining three stations were sampled seven times in 1994-1995. Dissolved-oxygen concentrations were below the USEPA criteria for the protection of aquatic life one time at each of four stations. pH exceeded USEPA criteria for freshwater aquatic life one time at each of three stations. The highest reported pH was 11.3 in Fall Kill site two (National Park Service ROVA06) in February 1995. Total chloride concentration exceeded the USEPA drinking-water criteria at the pond on Fall Kill in December 1978 (National Park Service, 1995a). Two sites on Meriches Kill in the Franklin D Roosevelt NHS and two sites on Crum Elbow Creek in the Vanderbilt Mansion NHS were measured for pH as many as seven times from 1994 to 1995. The pH for one observation at each site exceeded USEPA criteria for freshwater aquatic life.

Eleanor Roosevelt NHS has more data than the other two sites in ROVA, including data on water quality and aquatic biological resources (Pandullo-Quirk Associates, 1979); however, these data are 11 years old. Although the 1979 data were not collected in a way to provide evidence to justify a classification upgrade, Fall-Kill Creek met the water-quality standards for Class A streams (suitable for drinking and all other uses) at the time of collection. Any effort to upgrade stream classification would require additional data collection. William Bode with the Water Division of the Department of Environmental Conservation in Albany completed two macroinvertebrate studies in the park (David Hayes, National Park Service, oral commun., 2003).

A bathymetric study of the impounded part of Fall-Kill Creek was conducted by Pandullo-Quirk Associates (1979). Water-quantity data are not available for Vanderbilt Mansion NHS or for the Home of Franklin D. Roosevelt NHS. The closest streamflow gaging-stations that are still in continuous operation are Rondout Creek at Rosendale, New York (USGS station 01367500) and Wappinger Creek near Wappingers Falls New York (USGS station 01372500) with drainage areas of 383 and 181 square miles respectively. There was a streamflow gaging-station on Crum Elbow Creek at Hyde Park New York with a drainage area of 17.3 square miles that was in operation from 1960-1962.

Currently, there is an effort to restore Val-Kill Pond, which was created by a dam. An environmental assessment for this effort has been initiated, and water-quality monitoring for this project probably will be done by Park Service staff.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

Water quality in the park is considered good. The major potential polluters of park waters are municipal water treatment plants, leach field runoff from nearby homes, salt used in road maintenance, agricultural runoff, and the release of toxic material from industrial or commercial facilities (fig. 11). Contamination of private wells along Haviland Road (north of Val-Kill) by benzene, a petroleum compound, has occurred. It is possible that the material could enter either the natural or domestic water supplies at Val-

Kill. There are currently no water-quantity issues in the park. Flow levels are adequate to preserve natural processes and cultural features. There are no known flow reductions by upstream landowners.

Septic systems and residential development are a considerable threat to water quality at the park, according to David Hayes (National Park Service, oral commun., 2003). Most of the 25,000 people in Hyde Park have houses with septic systems, which may be contributing to eutrophication of the surfacewater. Agriculture is much less of an issue, as there is only one active farm left on the western edge of Hyde Park. None of the waterbodies flowing through the park are on USEPA's 305(b) or 303(d) lists for the state.

Saint-Gaudens National Historic Site

SAGA is a 150-acre rural park approximately 15 miles south of Lebanon in Cornish, New Hampshire. Freshwater bodies inside the park boundaries include Blow-Me-Down Brook, Blow-Me-Up Brook, Blow-Me-Down Pond, wetlands surrounding Blow-Me-Down Pond, and a farm pond (fig.12). Roughly half of the park is bordered by stream and pond habitats. Blow-Me-Up Brook winds along the northern edge of the property through steep ravines before it merges with the larger Blow-Me-Down Brook, which then flows into Blow-Me-Down Pond. Both Blow-Me-Down Pond and the farm pond are manmade and have impoundments at their outlets. Blow-Me-Down Pond is 5-acre body of water and water depths are 7-8 ft by the dam and average 3.8 ft over the pond as a whole (Cronan and Associates, 1981).

Water-Quality and Water-Quantity Monitoring and Research

A Baseline Water-Quality Data Inventory and Analysis for SAGA was completed in August 2000 (National Park Service, 2000). This inventory of data in STORET shows that historic water-quality monitoring in the park has been sporadic and(or) one-time efforts. There are 13 surface-water locations and one ground-water well where water-quality monitoring has occurred. The USGS has two historical stations in the park-- a surface-water-quality station on Blow-Me-Up Brook where 27 water-quality parameters were measured one time in 1967 and a ground-water well where 86 water-quality parameters were measured one time in 1988 (U.S. Geological Survey, 2003).

Cronan and Associates (1981) mapped the pond bathymetry and the wetlands and measured approximately 13 water-quality parameters four times during 1 year at six locations in the park in 1980. The NPS measured 22 water-quality parameters in the discharge from Blow-Me-Down Pond from 1 to 3 times each from 1982 to1991 (Roman, 1992). The Soil Conservation Service mapped the 10-, 100- and 500-year flood plain of Blow-Me-Down Pond in 1977. A water-resources monitoring study plan by Brenan Zubricki was completed in 1995 (Zubricki, 1995).

Currently (2004), the NPS has a water-quality monitoring program in place at five stations inside the park and one station just upstream from the park on Blow-Me-Down Brook. Inside the park, three stations are on Blow-Me-Down Brook, one station is on Blow-Me-Up Brook, and one station is on Blow-Me-Down Pond. This network has been in place since 1997; data from this network are reported annually (Walasewicz, 2002). Fifteen to twenty water-quality parameters, including water temperature, water depth, dissolved oxygen, conductivity, pH, and turbidity are measured monthly at all stations from May to November. Instantaneous discharge is measured monthly at three stations in the park from May to November. Inorganic nutrients (nitrogen and phosphorus) are measured monthly from June to November. Fecal coliforms are measured three times at four stations and biological assessments (The Izaak Walton League of America's Stream Quality Surveys) are conducted four times at four stations each year. These data and the annual report are all prepared and reviewed internally by SAGA park staff.

The closest active continuous-record streamflow gaging-station is the Ottauquechee River at North Hartland, Vermont (USGS station 01151500). This station is approximately 5 miles north of park, has a drainage area of 221 square miles, and a period of record from 1930 to the present (2004). The Sugar River at West Claremont, New Hampshire (USGS 01152500) is approximately 10 miles south of park, has a drainage area of 269 square miles, and a period of record from 1928 to the present (2004).

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

Roman (1992) identified increased residential and commercial development in the watershed and atmospheric-deposition effects documented in the vicinity (i.e. Hubbard Brook) as potential threats to the aquatic ecosystem in the park (fig.13). Both Blow-Me-Up Brook and Blow-Me-Down Brook have headwaters adjacent to land uses such as residential septic systems, agriculture, logging, and development (Cronan and Associates, 1981; Walasewicz, 2002). Significant use of deicing chemicals on Route 12A and other areas also may pose a threat to SAGA aquatic resources (Cronan and Associates, 1981; Walasewicz, 2002). Blow-Me-Down Brook has been stocked with several thousand brook trout per year for the past 40 years, but there is little evidence of a sustained trout fishery, indicating that there is a close balance between stocking and removal and mortality (Cronan and Associates, 1981). There are no known industrial dischargers in or upstream from the park.

Cronan and Associates (1981) found relatively high levels of coliform bacteria and fecal streptococci. Biological health of the park's aquatic resources produced index values indicating that on average, the streams are in the upper end of the "fair" condition category (Walasewicz, 2002). No waterbodies in the park are currently listed on the USEPA's 303(d) or 305(b) lists for the state.

Saugus Iron Works National Historic Site

SAIR is a 9-acre park in eastern Massachusetts on the Saugus River in the town of Saugus. The Saugus River watershed extends approximately 45 miles and encompasses the park and several neighboring towns. The park area is a glacial outwash plain in the Boston Basin.

The Saugus River at SAIR is a tidally influenced perennial stream at the head of a riverine estuary with a watershed of 23.3 square miles. A small segment of the river and wetland surrounding it make up a large part of SAIR (fig. 14). The tidal influence is 1 ft, with storm surges to approximately 3 ft. A dam breach in 1957 caused a massive amount of silt and sediment to alter the river's open water condition at the industrial area that is now the NHS, and created a wetland marsh (National Park Service, 2003e).

Two freshwater springs are in the park. A natural spring yielding 35 gallons per minute and a well, fed from a second natural spring yielding 5 to 6 gallons per minute, are near the industrial buildings (National Park Service, 2003e).

Water-Quality and Water-Quantity Monitoring and Research

The USGS maintains a streamflow gaging station just north of the park, Saugus River at Saugus Iron Works (USGS station 01102345) (U.S. Geological Survey, 2003). The period of record for this site is 1994 to present (2004) and the drainage area is 23.3 miles.

Stage, discharge, specific conductance, air and water temperature, precipitation, wind speed, and wind direction are currently reported in real time on the USGS website (http://waterdata.usgs.gov/ma/nwis/). In 2001, a cooperative project between the NPS and the USGS was conducted to update the existing streamflow gaging station to provide real-time flow data. A weather station was installed on the site's museum roof to work in conjunction with the updated streamflow gage to provide environmental information on the Saugus River Watershed. The weather station does not meet National Weather Service standards for station location, but is used by the Park for interpretive work. The USGS conducted discrete water-quality testing including concentrations of organic compounds, major, minor and trace inorganic compounds, physical properties, and radiochemicals between 1994 and 2001 (http://waterdata.usgs.gov/ma/nwis/).

Water-quality testing along the Saugus River, and specifically at SAIR's stone bridge over the Saugus River, has been conducted monthly (May through October) since 1998 by the Saugus River Watershed Council. Parameters sampled include bacteria, pH, turbidity, and dissolved oxygen (Joan LaBlanc, Saugus River Watershed Council, written commun., 2003).

In 1989 through 1990, Hudsonia Limited conducted a baseline assessment of the Saugus River system (Tashiro and others, 1991), analyzing physical, chemical and biological parameters from 10 stations along the river, including one station at Saugus Iron Works that had been documented by Sandy Wignot (SAIR seasonal Park Ranger), in a student report "Baseline Water-Quality Data for the Saugus River" in spring 1988.

The Massachusetts Division of Water Pollution Control assessed water quality of the Saugus River at 12 sampling stations in 1982. The Army Corps of Engineers sampled the estuarine reaches (lower 4.7 miles) during the period 1982-1984 and again in 1986 (U.S. Army Cops of Engineers, 1989).

Massachusetts DEP conducted an extensive water-quality assessment of the North Coastal Basin in Massachusetts, including the Saugus River Basin (Massachusetts Department of Environmental Protection, 1998). Massachusetts DEP collected background water-quality data and macroinvertebrate samples during 1997 and 1998. One sampling location was just east of the park.

Environmental consultant firm, Gomez and Sullivan completed a Saugus River water budget and instream flow study in 2002 for the Massachusetts Department of Environmental Management (Gomez and Sullivan, 2002) in order to evaluate the relation between streamflow regulation in the Saugus River and aquatic habitat needs. The section of the river that runs through SAIR is included.

The following summary describes various surveys, analyses, and reviews of the contaminated sediments in NHS area (Daniel Noon, National Park Service, written commun., 2003): In November 1993, Goff-Chem, Inc. collected three soil cores at five depths near the dock and slag pile (Goff-Chem, Inc, 1994). The metal concentrations for this area generally exceeded "average" geologic concentrations, suggesting an anthropogenic source. Arsenic concentrations exceeded Imminent Hazard criteria at depths of 3.0 and 5.0 feet (Woodard and Curran environmental Services, 1995).

In addition, an initial site investigation was conducted by Goff-Chem, Inc. (1996). This investigation included sediment samples from the wetland and slag pile, well borings, and water-quality samples. The study concluded that the wetland on the western side of the Saugus River is contaminated with polyaromatic hydrocarbons, the slag pile has arsenic levels above the Imminent Hazard threshold, and that particulate from the slag pile is the likely source of arsenic in the wetland (Goff-Chem, 1996).

The USGS, in cooperation with the Massachusetts DEP, is currently conducting a study to sample sediments for heavy metals in eight coastal-Massachusetts locations (R.F. Breault, USGS, written comm, 2003). One of the sediment samples was collected on the Saugus River just downstream from SAIR. Results for this study are not yet published.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

The Saugus River in an urban area in Massachusetts has been affected by human activities for over 300 years (Gomez and Sullivan, 2002). Over the last three and a half centuries, the navigability of the Saugus River from the coast to the Iron Works has significantly changed with the construction and repair of bridges, the removal of dams, and the invasion of non-native plant species.

In 1957, a dam was breached upriver from the Iron Works. This breach deposited a large amount of sediment into the basin. In subsequent years, vegetation began to grow upon the sediment throughout the Iron Works site. The mudflats and fringing wetlands that were once prevalent along the Saugus River are now replaced with large stands of phragmites, purple loosestrife, and narrow-leaved cattail. Currently, about 4 acres of the river are choked with invasive plants, displacing native species, contributing to the channeling (narrowing and deepening) of the riverway, and threatening the health of wetland habitats. The most prolific invasive species are common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*polygonum* *cuspidatum*), multiflora rose (*Rosa multiflora*), curly pondweed (*Potamogeton crispus*), mugwort (*Artemisia vulgaris*), and Norway maple (*Acer platanoides*).

Sewage is another threat to water quality in the Saugus River. A new sewage pumping station was installed by the town of Saugus in 1987 to pump sewage from homes previously served by septic systems: however, many older septic systems in the watershed continue to leach their contents into the river.

Seasonal flooding of the Saugus River also is a potential ecosystem threat. Although periodic flooding is present in a healthy freshwater ecosystem, the extent of the pavement and other impermeable surfaces prevalent in the urban areas surrounding the Saugus River leads to scouring of the river channel and contributes large pollution loads to the river. Household waste is carried from upstream, some of which is deposited in park boundaries as the waters recede (Tashiro and others, 1991).

The NPS is proposing to restore the Saugus Iron Works area and adjacent riverbed and wetlands within the historic site (Daniel Noon, National Park Service, written commun., 2003). An important goal of this restoration project is control of invasive plants.

A number of additional efforts are underway to improve the quality of the Saugus River. The Saugus River Advocacy Group has received technical support from the NPS. The Saugus River is registered with the Massachusetts Adopt-A-Stream Program, through which the group hopes to improve the quality of the river environment for ecological and recreational purposes. The Massachusetts Department of Environmental Management (DEM) is working in cooperation with the Lynn Water and Sewer Commission to better control and time withdrawals of freshwater from the Saugus River, which are used as the drinking supply for the city of Lynn. The Massachusetts

Department of Environmental Management also is seeking funding to install a fish ladder at the Lynn Water and Sewer Commission diversion dam, at the Colonial Hilton in Lynnfield, to return alewives to their natural spawning areas at Lake Quannapowet, Wakefield (National Park Service, 2003e).

The Saugus River, which runs through SAIR, is included on the Massachusetts 303(d) list. The specific concern in this river is the level of fecal coliform bacteria. The Saugus River is currently classified by the state as a B/SB river, which means it is suitable for fishing and swimming, but some evidence exists that the Saugus River may be exceeding the limits for a B/SB rating (Tashiro and others, 1991).

Saratoga National Historical Park

SARA which is in Saratoga County, New York, contains 3,406 acres along the Hudson River and is composed of four non-contiguous sites. The Battlefield Unit is in Stillwater and is what many people think of as the park. The Old Saratoga Unit, in the villages of Schuylerville and Victory, contains the Schuyler Estate, the Saratoga Monument, and Victory Woods, a 22-acre wooded tract locally known as the Garber Tract. Victory Woods was added to the park in the 1960s through a donation by its owners. It has never been open to visitors, and no programs or interpretive services are offered there. Only the Battlefield Unit is shown in figures 16 and 17.

Tributaries to the Hudson River drain SARA, including Kroma-Kill, Mill Creek, American’s Creek, and Devil’s Hollow (fig.16). Originating northeast of the park, Kroma Kill drains the largest area and flows through the park. All of the Mill Creek drainage is contained within park boundaries. American’s Creek is the name given by the park to a small stream entering the Hudson River just south of the Mill Creek confluence with the Hudson River. Devil's Hollow (locally used name) in the southern end of the park flows through a hemlock-laden cascade with a gradient drop of more than 100 feet. Devil's Hollow was historically called Great Fall Creek (Vana-Miller and others, 2001). The Champlain Canal connects the city of Troy to Lake Champlain and was completed in 1823. It runs along Route 4 on the eastern edge of the park.

The park has 176 acres of palustrine wetlands making up approximately 6 percent of the park (Tiner and others, 2000). Two small farm ponds and 4 springs are in the park.

WATER-QUALITY AND WATER-QUANTITY MONITORING AND RESEARCH

NPS's Water Resources Division in cooperation with SARA staff developed a Water Resources Management Plan in January 2001 (Vana-Miller and others, 2001). This plan includes an inventory of existing freshwater resources, the monitoring that has been done on these resources, identification of potential threats to the freshwater ecosystem, and a proposed water-quality monitoring plan. It has an extensive reference list that includes references for all freshwater-quality or quantity data that has been collected near the park, and summarizes most of these data. This document is at the park and should be used to guide any water-quality monitoring conducted in the park.

A Baseline Water-Quality Data Inventory and Assessment was completed for SARA in 1997 (National Park Service, 1997b). Sixteen water-quality stations inside the park were found in STORET; all are monitored internally by the NPS. For 11 stations, data collection occurred between 1987 and 1990, and included 8 water-quality parameters (water temperature, specific conductance, dissolved oxygen, pH, salinity, nitrate, lead, and phosphate). Water-quality monitoring at these stations also occurred during 1991; these data were not entered into STORET, but are available in files at the park. Five additional stations were tested for polychlorinated biphenyls (PCBs) and (or) lead one time in 1987. These data are stored at the park (Chris Martin, National Park Service, written commun., 2003). Currently (2004), no water-quality monitoring is taking place in the park.

One monitoring well (USGS station 430013073370401) was monitored for water quality by the USGS from 1959 to 1995. Although USGS no longer maintains this well, park staff continue to record monthly water levels (Chris Martin, National Park Service, written commun., 2003). The Hudson River Basin was the subject of a USGS National Water-Quality Assessment Program (NAWQA) study. Although no monitoring sites were inside the park, other sites in the Hudson Basin may be helpful in identifying potential natural and anthropogenic water-quality issues in the park. The major findings of the NAWQA study from 1992-1995 are summarized in Wall and others (1998).

A wetland inventory for the park (Tiner and others, 2000) was conducted by the USFWS in conjunction with the NWI. An intensive investigation of the ground-water resources in the park was conducted by Heath and others (1963). The results of this investigation are summarized in a water resources management plan for the park (Vana-Miller and others, 2001).

Other than the Hudson River, no fluvial system in or adjacent to SARA has been monitored for discharge on a consistent basis. Heath and others (1963) measured the flow from the two major springs in the park. The nearest USGS station that is most representative of streamflow conditions at the park is the Hudson River at Stillwater (USGS station 01331095). The difference between the size of the drainage area of the

Hudson River (3,773 square miles) at this location and any of the small streams in the park is significant.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

An extensive summary of water-quality issues in and around SARA can be found in the water resources management plan for the park (Vana-Miller and others, 2001). A brief summary of issues in the park follows. A considerable threat to aquatic ecosystems in the park is nonpoint-source pollution, including agriculture (dairy farms) and residential development upstream from the park (Chris Martin, National Park Service, oral commun., 2003) (fig. 17). In the case of Mill Creek, the stream flows out of the park boundary, across agricultural land and then back into the park. Specific stressors to the freshwater ecosystem include atmospheric deposition, road salt from road runoff, failing septic systems, beaver re-colonization of Mill Creek, and the potential risk of zebra mussel colonization (Vana-Miller, 2001).

The park is bounded by the Hudson River, into which all of its streams drain. Although the Park boundary is the mean high-water mark of the Hudson River, backwater into Vyle Pond and other areas affects the park. The Hudson River is a Superfund site and if the Hudson is dredged for PCBs, as is planned (Chris Martin, National Park Service, oral commun., 2003), backwater would have an even greater effect on the park. There are no industrial or municipal facilities in the park or in the watersheds that drain into the park.

The results of the SARA water-quality criteria screen found that four groups of parameters exceeded USEPA screening criteria at least once within the park. Concentrations of dissolved oxygen, pH, fecal coliform, and lead exceeded the respective

USEPA criteria for the protection of freshwater aquatic life. Lead exceeded the drinking-water criteria in three locations: (1) on the Old Champlain Canal 0.5 mile north of where Kroma Kill enters the canal (NPS SARA0042), (2) just downstream from the confluence of Kroma Kill and a tributary to Kroma Kill (NPS SARA0049) at the northern boundary of the park, and (3) in an area of backwater created by the Hudson River near where American Creek enters Hudson River (NPS SARA058). Fecal coliform exceeded NPS Water Resources Division screening limits for freshwater bathing at two locations: (1) NPS station SARA0049 and (2) on Mill Creek, just downstream from the confluence of Robbie's Ditch and Mill Creek (NPS station SARA0053). Dissolved-oxygen concentrations exceeded the USEPA standards at two locations on Mill Creek (NPS stations SARA0061 and SARA0054), one location on Devil's Hollow (NPS station SARA0062), and one location on American Creek near where it enters the Hudson River (NPS station SARA0057). pH exceeded the screening criteria at NPS stations SARA0061 and SARA0057. None of the waterbodies flowing through the park are on USEPA's 305(b) or 303(d) lists for the state.

Weir Farm National Historic Site

WEFA is a historic farmstead and reserve in the towns of Wilton and Ridgefield in western Connecticut that is in the Norwalk River watershed (fig. 18). It consists of 60 acres including two new parcels of land, one-half a mile away, totaling 11 acres that have recently been added to the park.

Water resources at WEFA include 15 acres of aquatic habitat, including an artificial pond just under 4 acres (Weir Pond), and herbaceous or shrub/scrub wetlands. The entire park is in a geologic region known as the Connecticut Western Uplands, an area of upland hills and valleys with granitic soils and underlying schist and gneiss bedrock (Canavan and Siver, 1995). This geology influences the chemical composition of the major waterbodies making them more alkaline with a higher pH and conductivity than other Connecticut lakes. Freshwater bodies include Weir Pond, an unnamed pond, an unnamed stream, some intermittent streams, seven wetland areas, and ground water. Ground water appears to contribute the majority of the base flow to the pond, which is 7 ft at its deepest point (U.S. Department of Agriculture, 1995).

The park lies in the Norwalk River watershed and drains north to the Cooper Pond Brook, which flows into the Norwalk River, and to the south to the Barrets Brook, which flows into Streets Pond. Streets Pond empties into Comstock Brook and into the Norwalk River. Several springs and streams, some intermittent, drain into the 4-acre pond, which was artificially impounded in 1896 (U.S. Department of Agriculture, 1995).

Water-Quality and Water-Quantity Monitoring and Research

A Baseline Water-Quality Data Inventory and Assessment was completed for this park in 1997 (National Park Service, 1997c). None of the monitoring stations found in STORET were in or upstream from the park. A Level I water-quality inventory was completed for WEFA because of the lack of water-quality data in the park (Farris and Chapman, 2000b). Additional Level I water-quality data was collected by park staff in the summer of 2000 (G. Waters and L. Skibiel, National Park Service, written commun., 2000).

Currently (2004), no long-term monitoring sites for water quality or water quantity are in the park, in the watershed upstream from the park, or in the study area as defined by the Baseline Water-Quality Data Inventory and Assessment (3 miles upstream or 1 mile downstream from the park). The closest USGS streamflow gaging-station is in South Wilton (USGS station 01209700) with a drainage area of 30 square miles.

A water-quality resource evaluation of the park was completed in 1995 (U.S. Department of Agriculture, 1995). Seven wetlands were identified and mapped on the site. Wetland areas drain into the Norwalk River or into Weir Pond.

Current and Emerging Threats to the Freshwater Aquatic Ecosystem

A concern regarding water quality in the park is the effect of adjacent residential development on the Weir Pond watershed and the various wetlands (fig. 19). Residential development can lead to nutrient loading in the watershed from septic systems, landscaping activities, and tree cutting that increases runoff. A proposed highway expansion project could affect the watershed of the wetlands in the northeastern corner of the park. Development projects in the Park, including a proposed restroom building, also may influence the water quality of aquatic resources. Other threats include atmospheric deposition, visitor use, and road runoff from development in the park. Land use adjacent to Weir Farm is low-density residential; many of the private residences are on 2- to 5-acre lots, are extensively landscaped, and are serviced by septic systems. This type of land use tends to be associated with increased nutrient loading from ground-water input and surface-water runoff.

Weir Pond has high seasonal levels of chlorophyll and turbidity and low seasonal levels of dissolved oxygen and secchi depth. The pond is approaching eutrophic conditions and is vulnerable to increased nutrient loading. It has a relatively low pH, and water clarity ranges from 4 to 5 ft (Farris and Chapman, 2000b). The intermittent stream and the one wetland monitored in the Level I Inventory showed high concentrations of dissolved nitrogen (Farris and Chapman, 2000b).

Although all rivers and lakes in Connecticut are on the USEPA's 303(d) list for FCA mercury, Weir Pond is not specifically listed on either the 305(b) or 303(d) list for the state.

SUMMARY

Freshwater resources in all parks in the NETN are subject to natural and anthropogenic threats. The overall goal of this project is to identify the natural range of variability in the park systems and to ascertain whether anthropogenic alterations to the ecosystems are driving water quality and (or) water quantity outside the normal range of variability. The purpose of this first phase of the project described in this report was to identify threats common to all parks as well as threats unique to individual parks. In addition, sources of baseline information on the freshwater aquatic resources in the parks were compiled, and current baseline monitoring was identified. Information regarding freshwater resources and threats to the water quality of these resources is integrated into conceptual models.

Common threats or stressors to freshwater resources in the parks in all cases include climate change, atmospheric deposition, development, visitor use, and invasive species, and commonly include agriculture. Threats that are an issue in some parks include industry and forestry.

None of the parks except ACAD have a streamflow gaging station or an active monitoring well within their boundaries. With the exception of SAIR, the parks do not have nearby streamflow gaging-stations with drainage areas similar enough to waterbodies in the park to use for estimating flow in the park.

Half of the NETN parks (ACAD, MORR, ROVA, SAGA, and SAIR) currently have a baseline water-quality monitoring program in place. Little or no baseline freshwater-quality monitoring is occurring in BOHA, MABI, MIMA, SARA or WEFA. Although limited lake monitoring has been done in ACAD for more than 30 years, the period of record in other parks where baseline monitoring has been done ranges from 5 to 20 years, and the level of quality assurance is variable. In several cases, additional monitoring variables have been added in recent years. Network wide aquatic monitoring variables (vital signs), justifications for these vital signs, and protocols will be selected in phase two of this project.

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Table 1. Summary of current freshwater-quality and -quantity monitoring in Northeast Temperate Network parks. [DOC, dissolved organic carbon; DIC, dissolved inorganic carbon; USGS, U.S. Geological Survey]

Park	Water-quality Monitoring	Parameters	Number of stations	Agency conducting monitoring	Frequency	Period of record
ACAD	lakes	Secchi disk, temperature, pH, dissolved oxygen, specific conductance, alkalinity	8 lakes	park staff	monthly (May-October)	Current program 1997-2004(some parameters since 1970)
	lakes	Secchi disk, temperature, pH, dissolved oxygen, specific conductance, color, DOC, total phosphorus, total nitrogen, chlorophyll a, ANC, DIC, major ions, epilimnetric core sample, bottom grab sample, light penetration	5	park staff	twice per summer	Current program 1997-2004(some parameters since 1970)
	streams	Benthic macroinvertebrates, habitat, temperature, pH, dissolved oxygen, specific conductance, color, flow	3	park staff and Maine Department of Environmental Protection	once per year	1997 –2004: 4 streams 1998 –2004: 6 streams
	ground water			USGS	continuous	2003-2004
BOHA	none	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
MABI	none	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
MIMA	none	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
MORR	streams	Temperature, pH, dissolved oxygen, specific conductance, chloride, total dissolved solids, salinity, fecal coli form	11	park staff	monthly (weekly in summer)	1982-2004
ROVA	streams	Temperature, pH, dissolved oxygen, salinity, specific conductance, chloride, alkalinity,	3	park staff (lab work contracted out since 1998)	monthly	1994- 2004
		phosphate, turbidity, nitrate			quarterly	
SAGA	streams	Temperature, dissolved oxygen, turbidity, pH, specific conductance, total nitrogen, total phosphorus, fecal coli form	5 in park (1 out)	park staff	monthly (May-November)	1997- 2004
SAIR	river-just outside park	Bacteria, turbidity, pH, dissolved oxygen	1 just outside park	Saugus River Watershed Council	monthly (May-October)	1998- 2004
SARA	none	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
WEFA	none	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

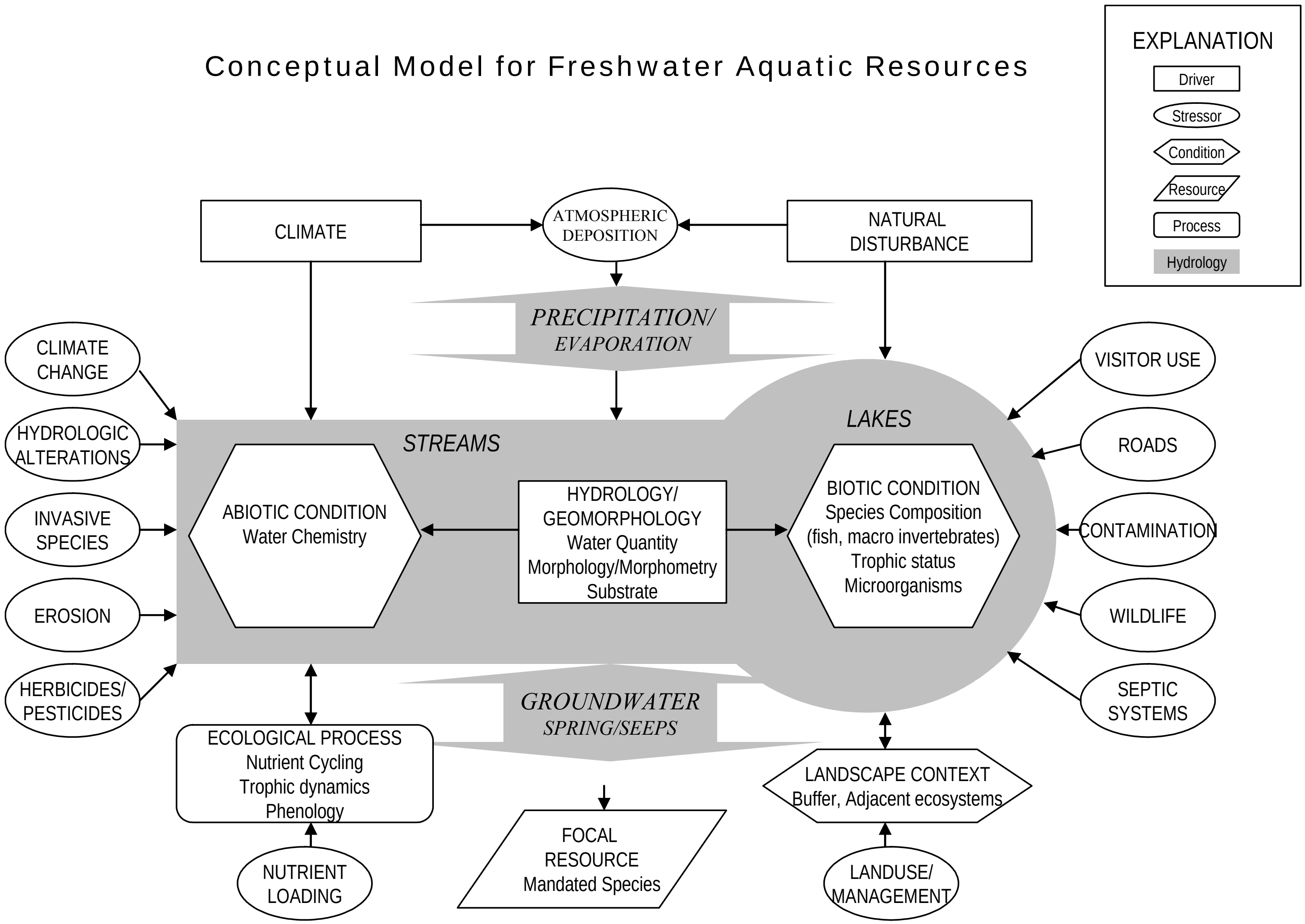

Figure 1. Conceptual relations among drivers, threats and attributes of freshwater ecosystems at Northeast Temperate Network Parks.

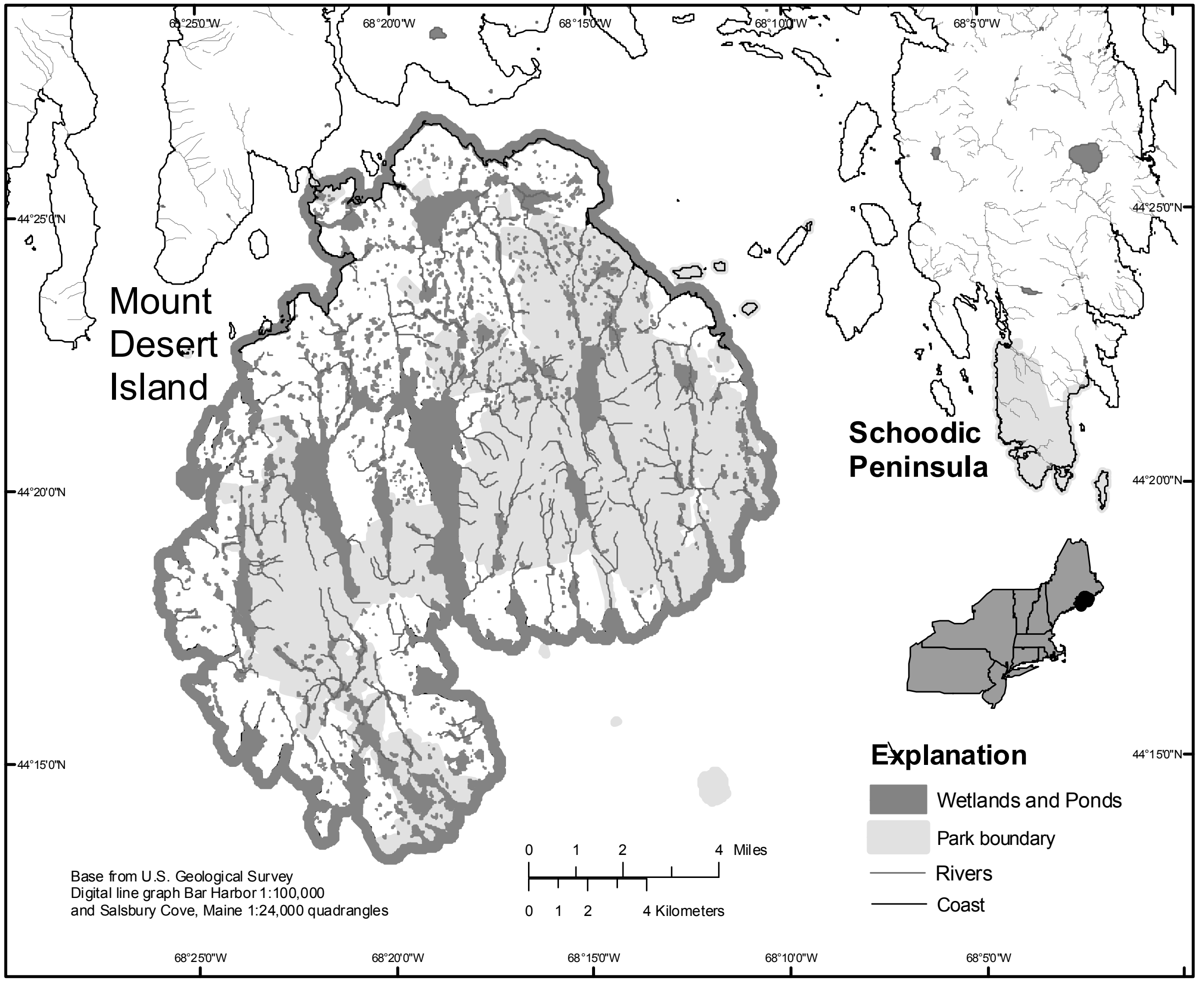

Figure 2. Freshwater resources at Acadia National Park, Maine [note: Isle au Haut not shown].

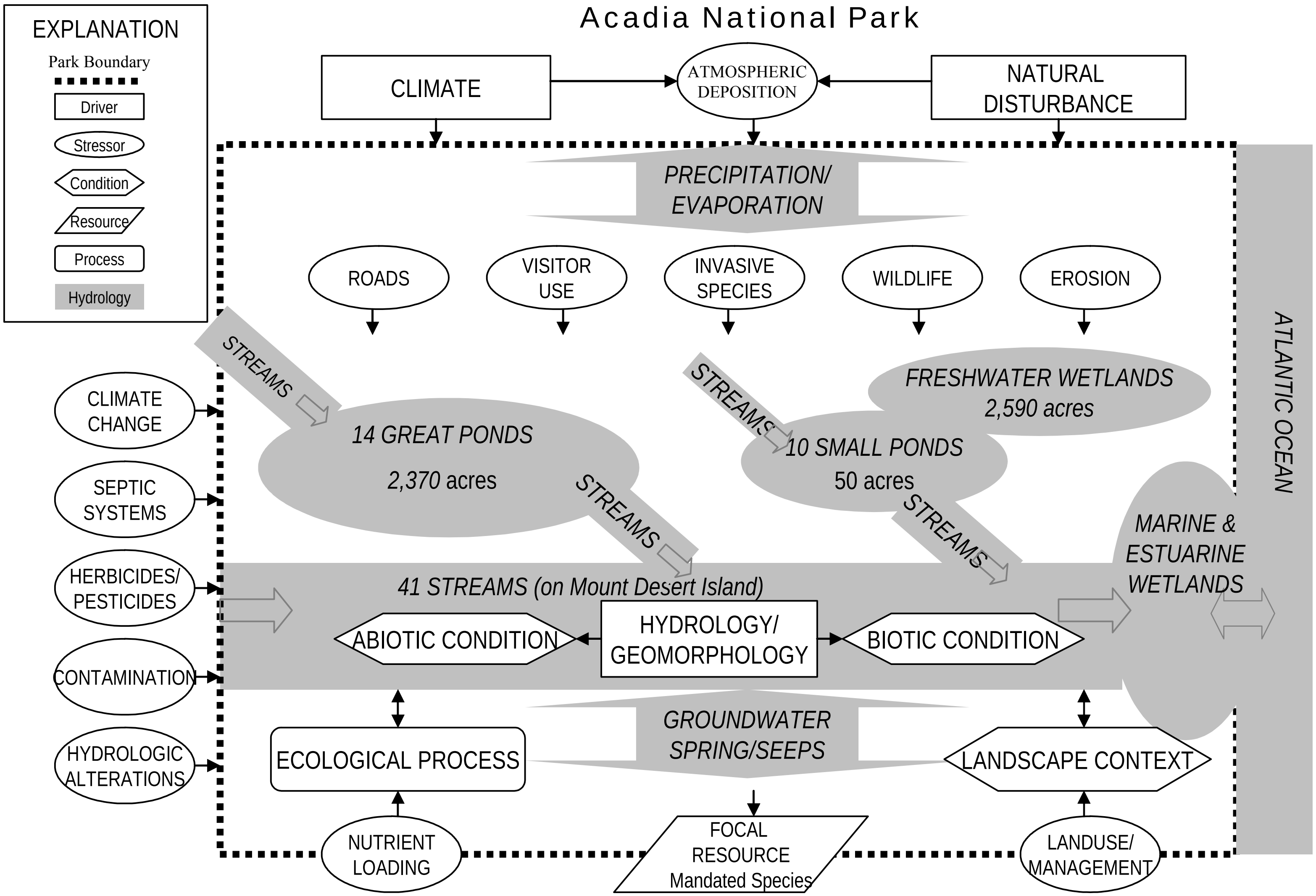

Figure 3. Conceptual model of freshwater ecosystems at Acadia National Park, Maine.

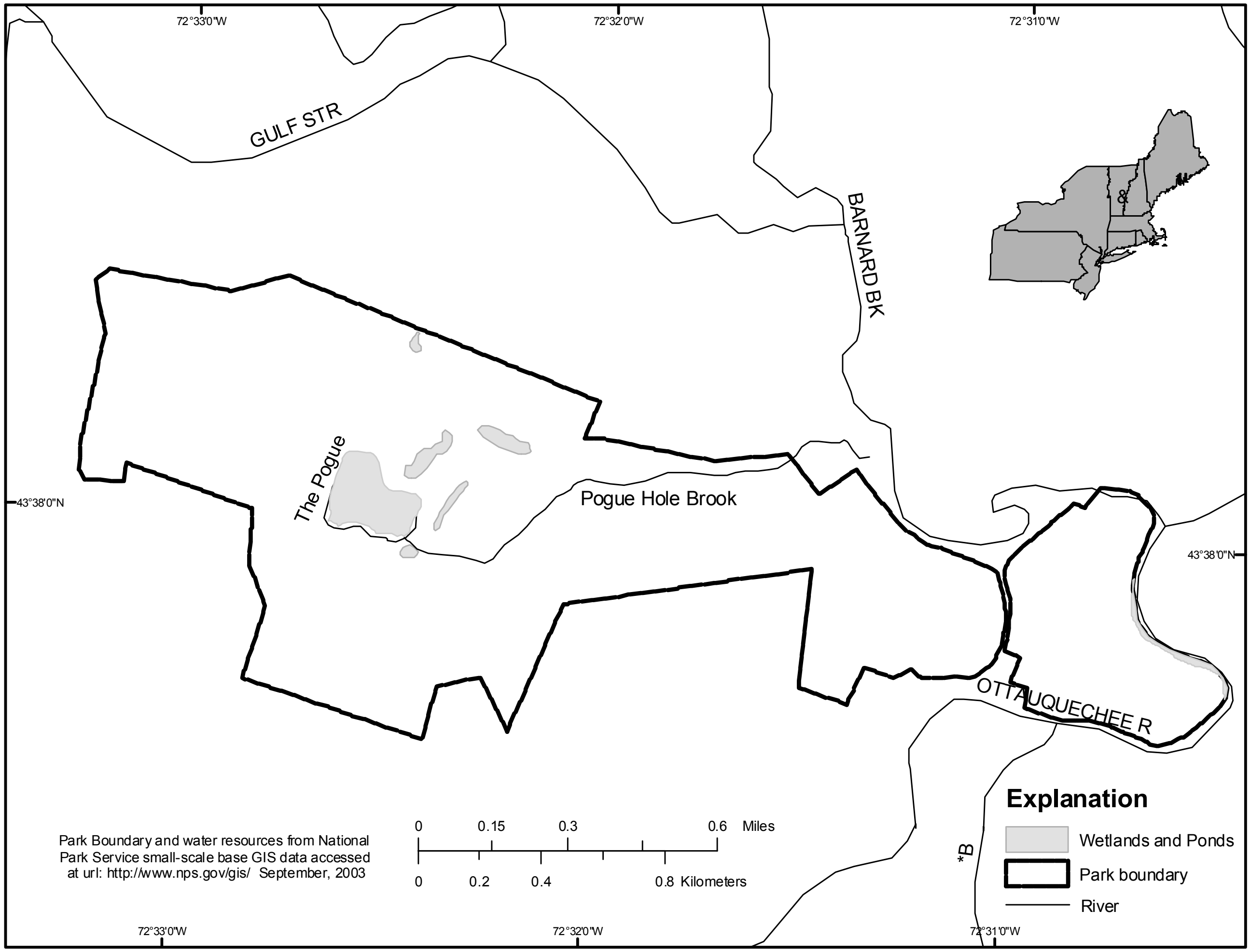

Figure 4. Freshwater resources at Marsh-Billings-Rockefeller National Historical Park, Vermont.

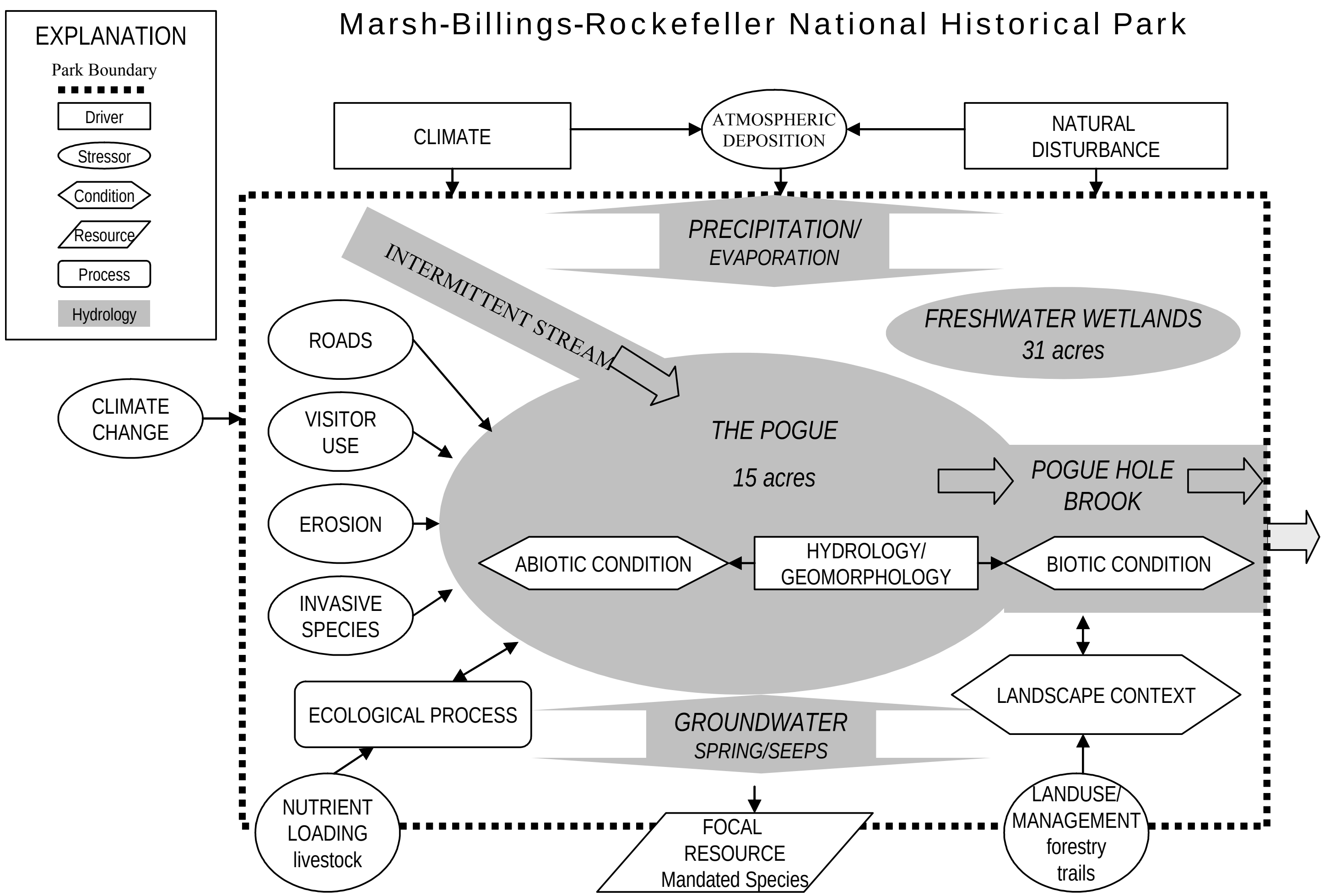

Figure 5. Conceptual model of freshwater ecosystems at Marsh-Billings-Rockefeller National Historical Park, Vermont.

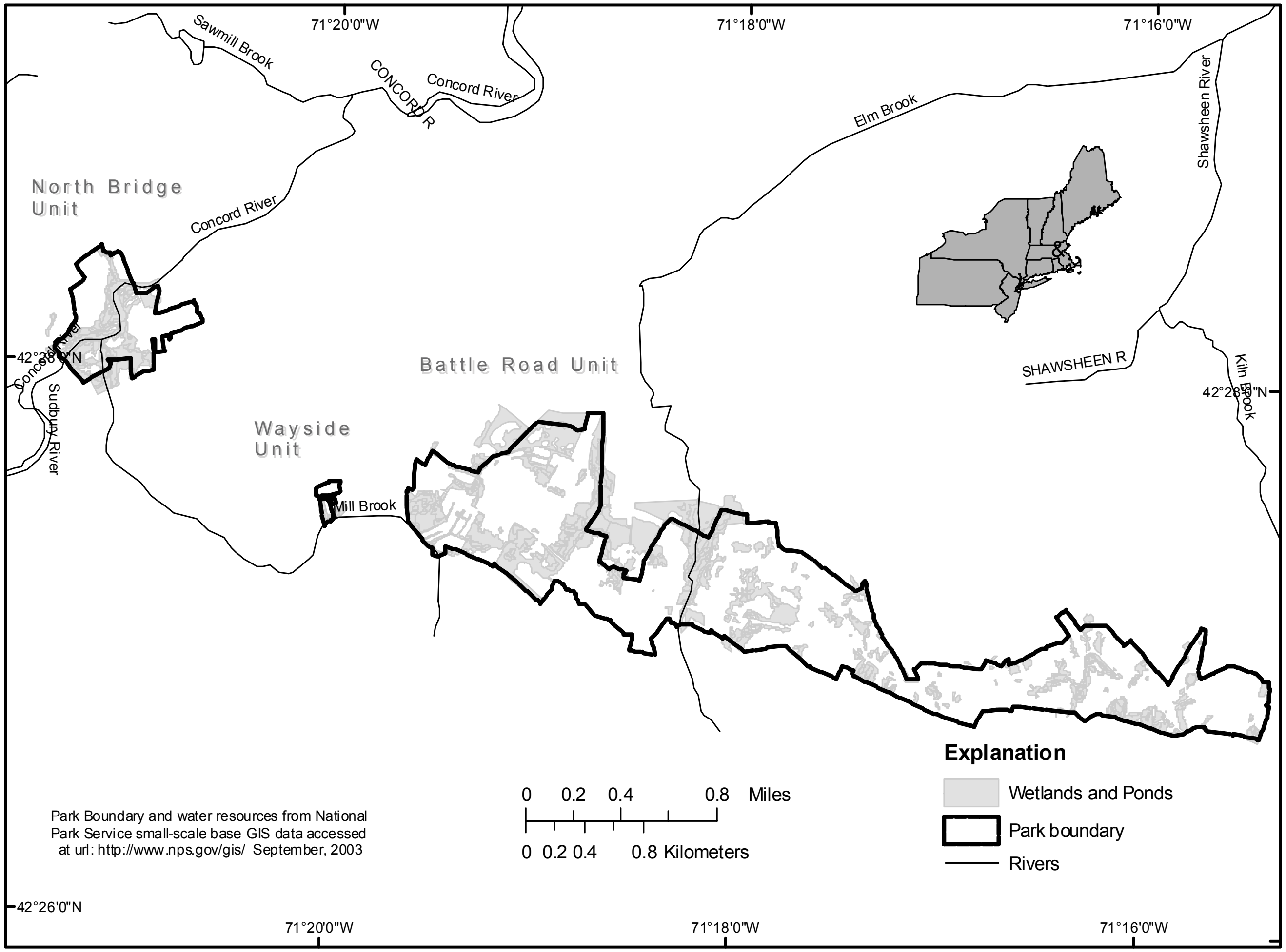

Figure 6. Freshwater resources at Minute-Man National Historical Park, Massachusetts.

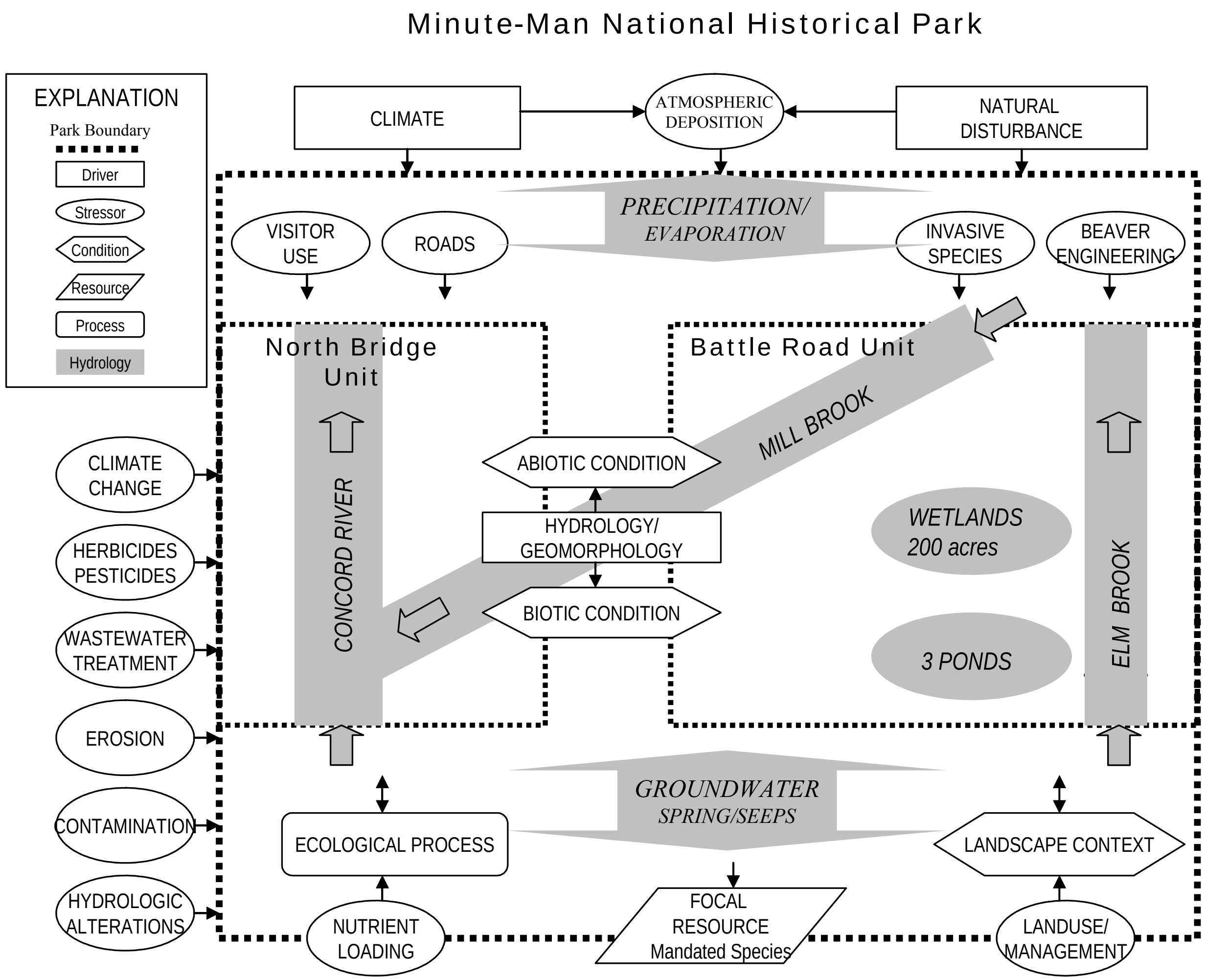

Figure 7. Conceptual model of freshwater ecosystems at Minute-Man National Historical Park, Massachusetts. [note: Wayside Unit not shown].

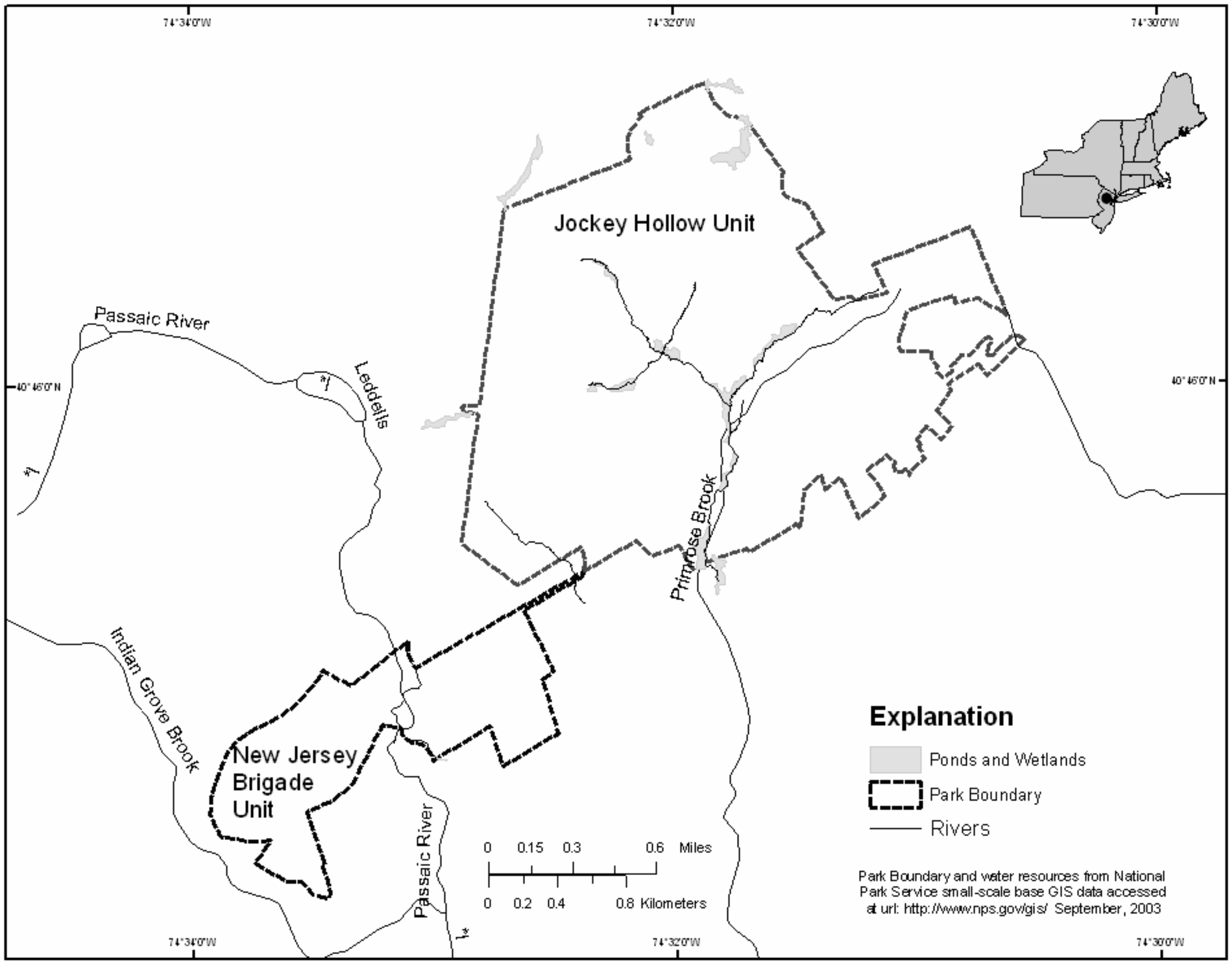

Figure 8. Freshwater resources at Morristown National Historical Park, New Jersey [note: Washington's headquarters Unit and Fort Nonsense Unit not shown].

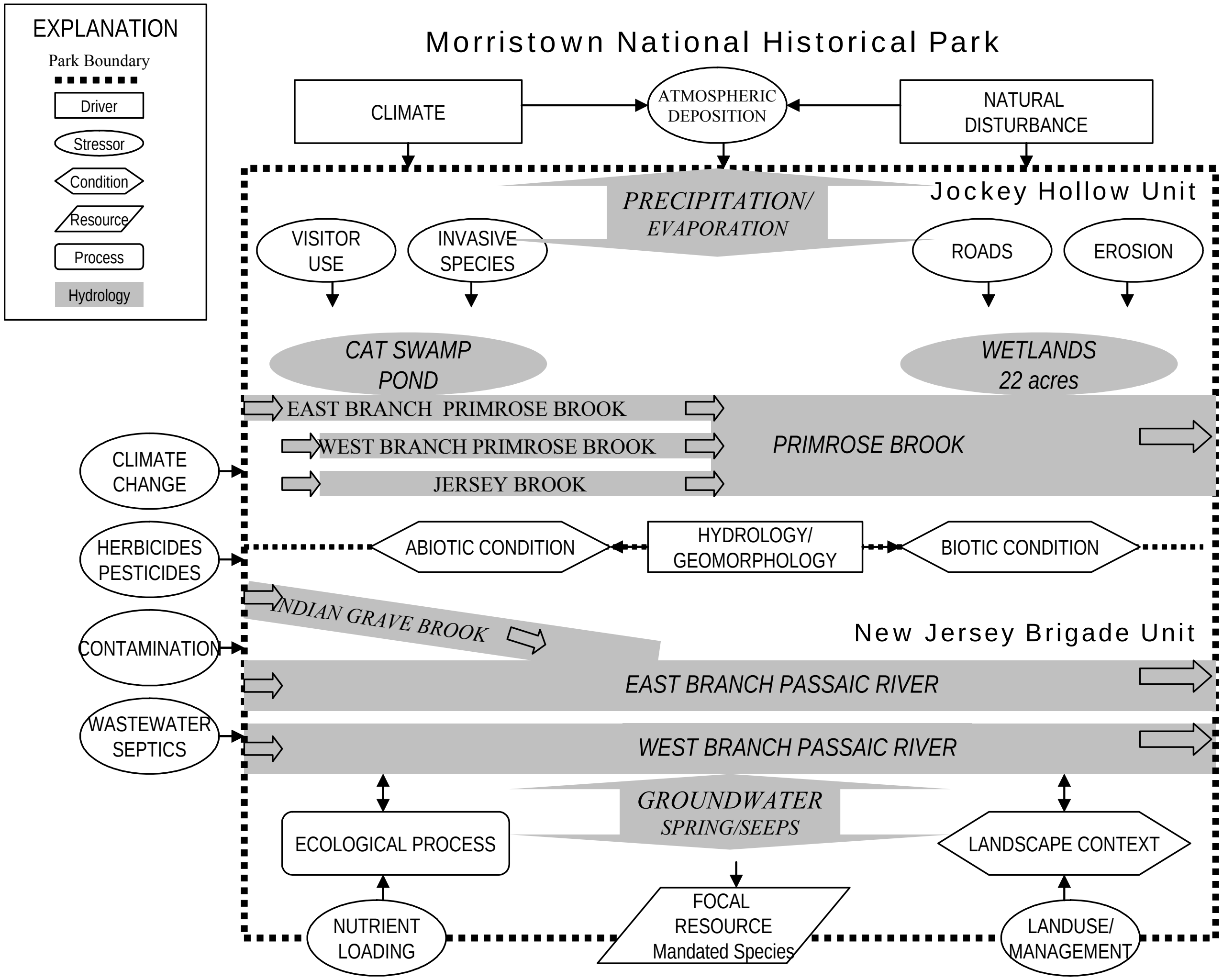

Figure 9. Conceptual model of freshwater ecosystems at Morristown National Historical Park, New Jersey.

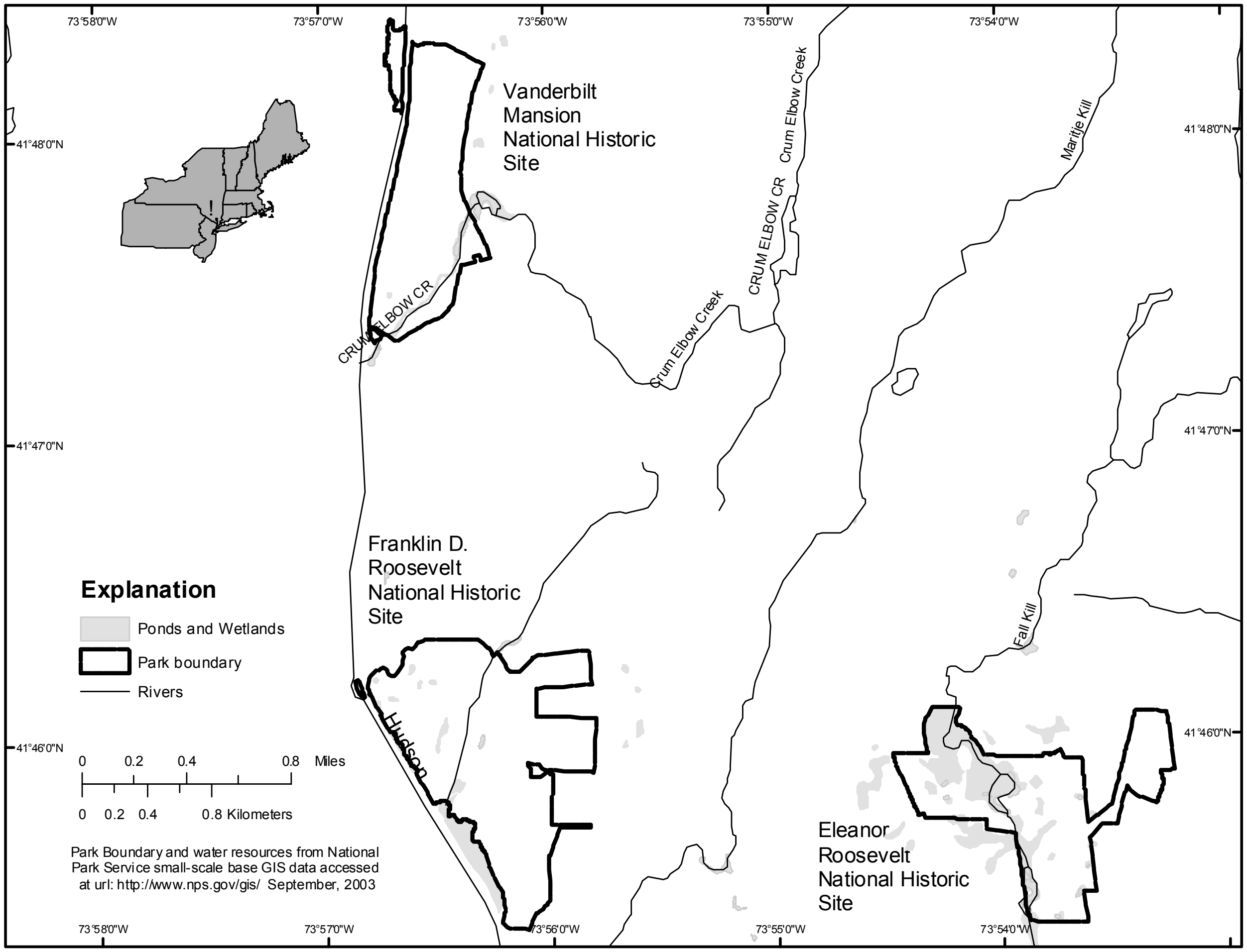

Figure 10. Freshwater resources at Roosevelt-Vanderbilt National Historic Sites, New York.

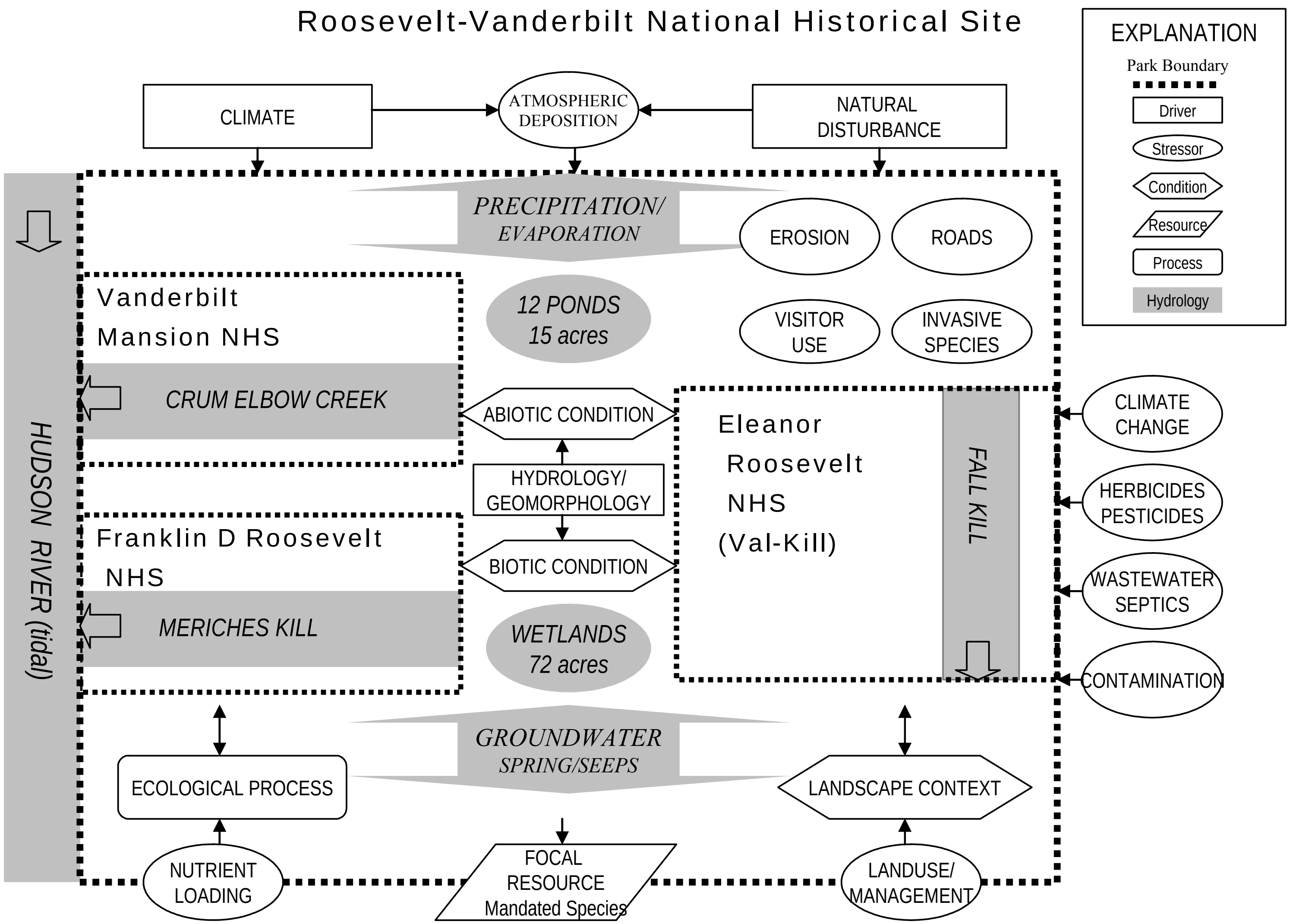

Figure 11. Conceptual model of freshwater ecosystems at Roosevelt-Vanderbilt National Historical Site, New York.

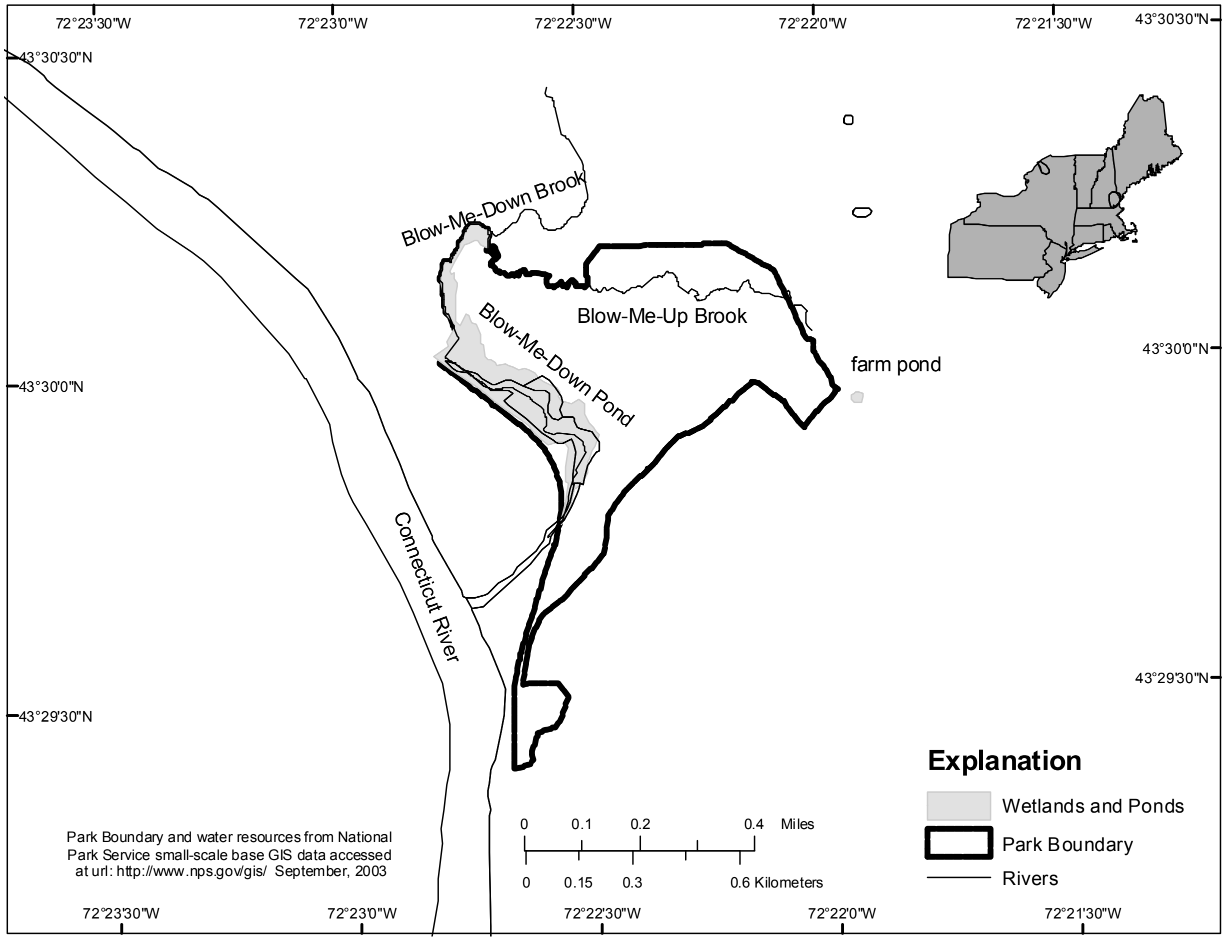

Figure 12. Freshwater resources at Saint-Gaudens National Historic Site, New Hampshire.

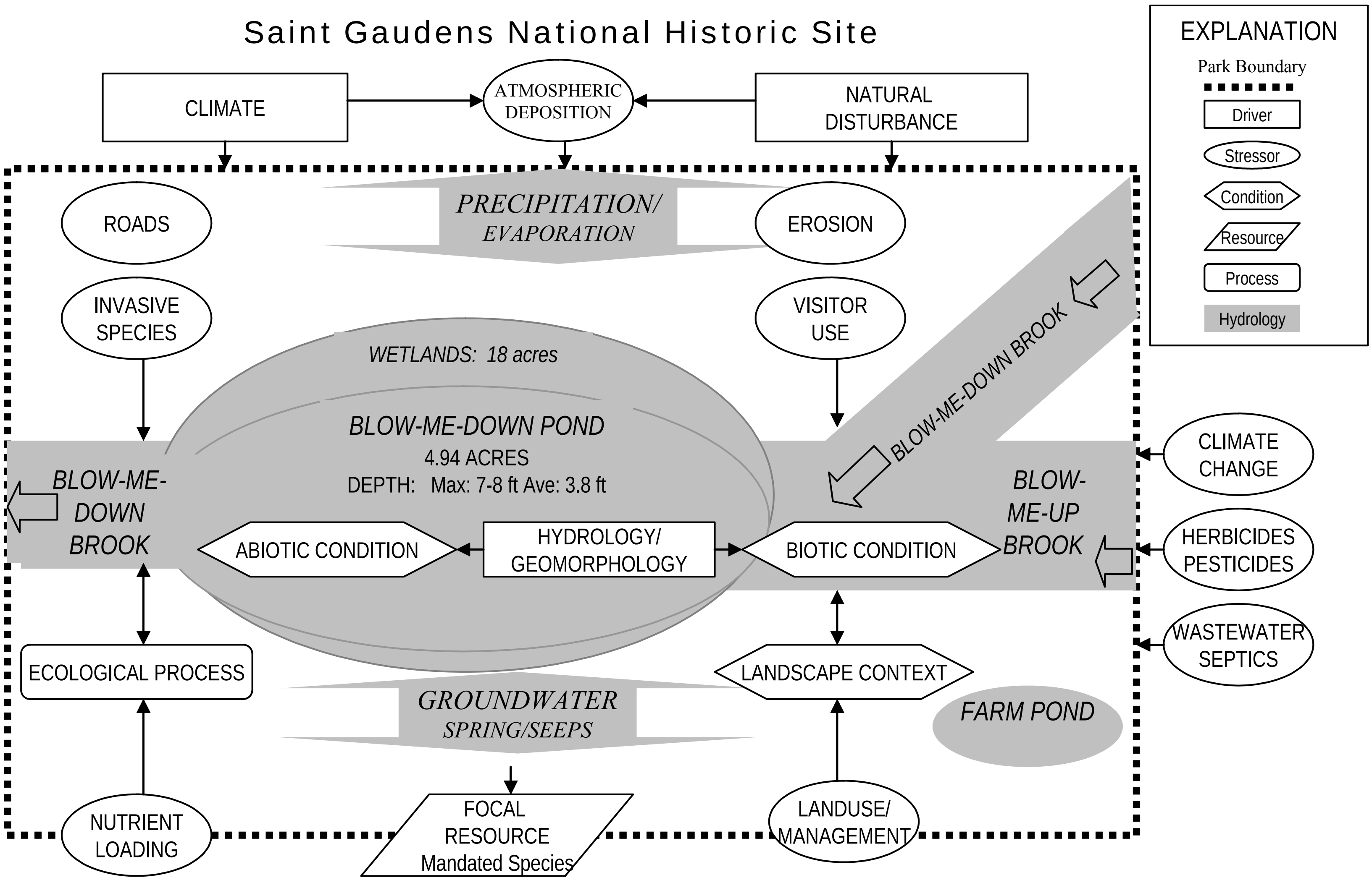

Figure 13. Conceptual model of freshwater ecosystems at Saint-Gaudens National Historical Site, New Hampshire.

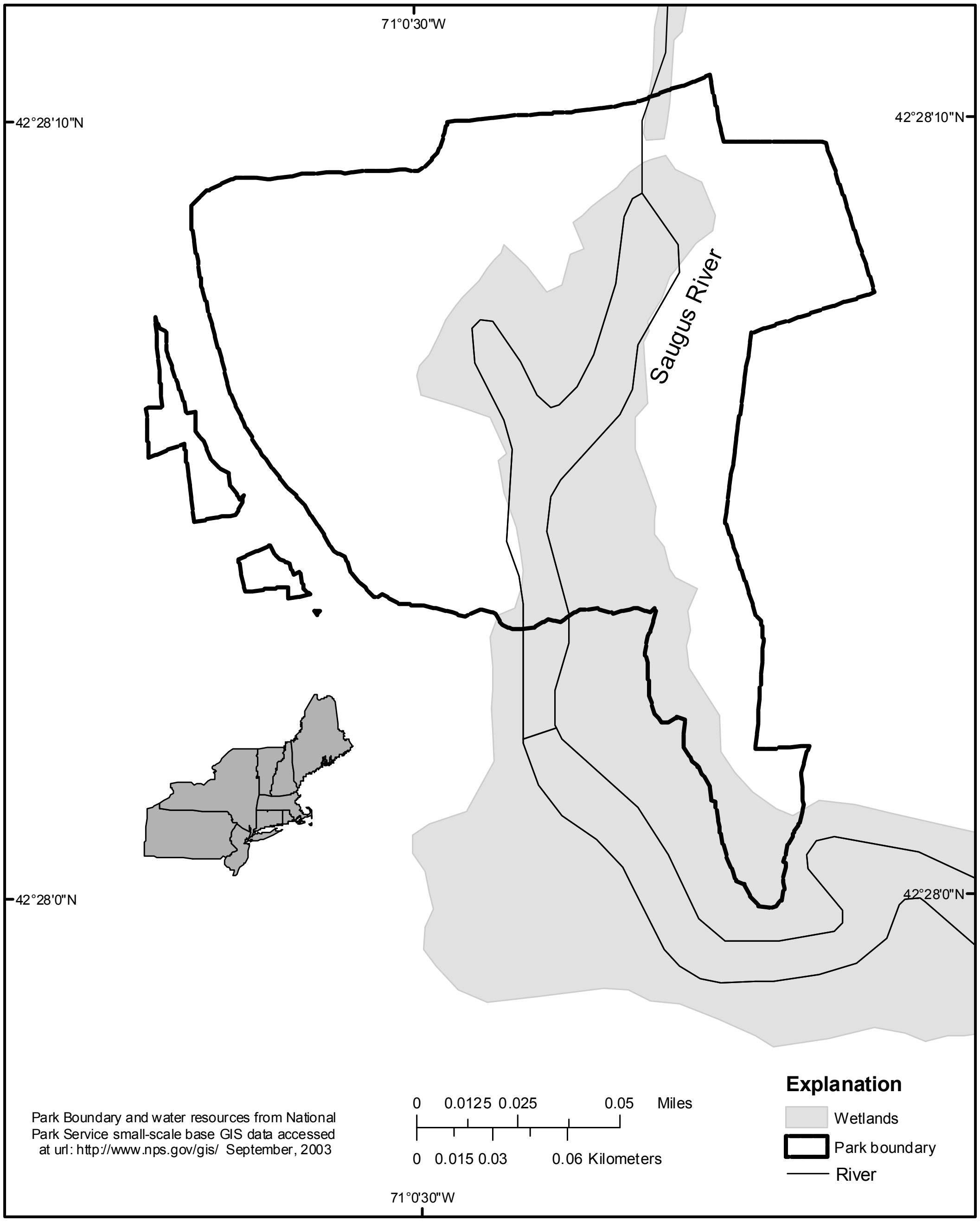

Figure 14. Freshwater resources at Saugus Iron Works National Historic Site, Massachusetts.

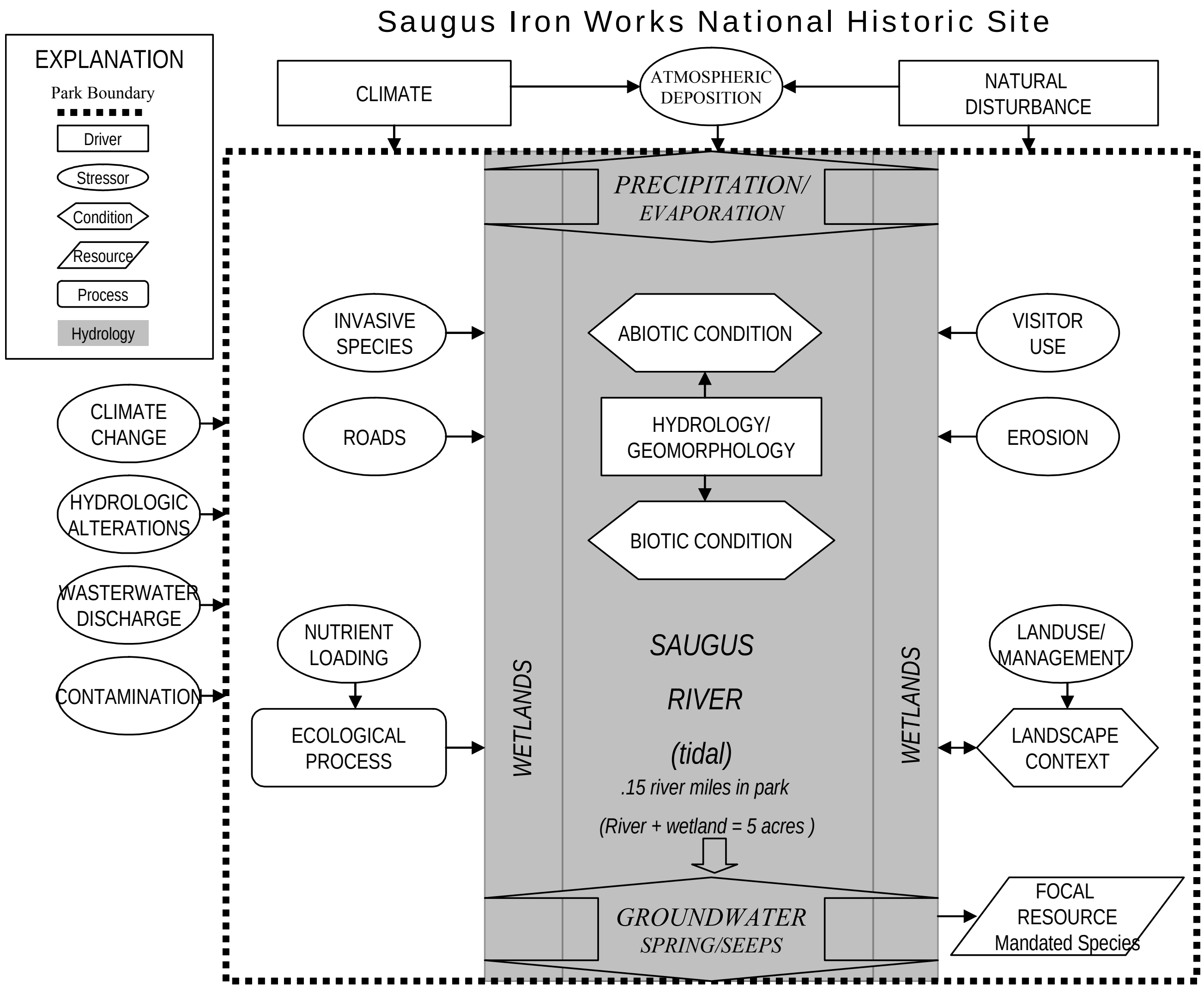

Figure 15. Conceptual model of freshwater ecosystems at Saugus Iron Works National Historic Site, Massachusetts.

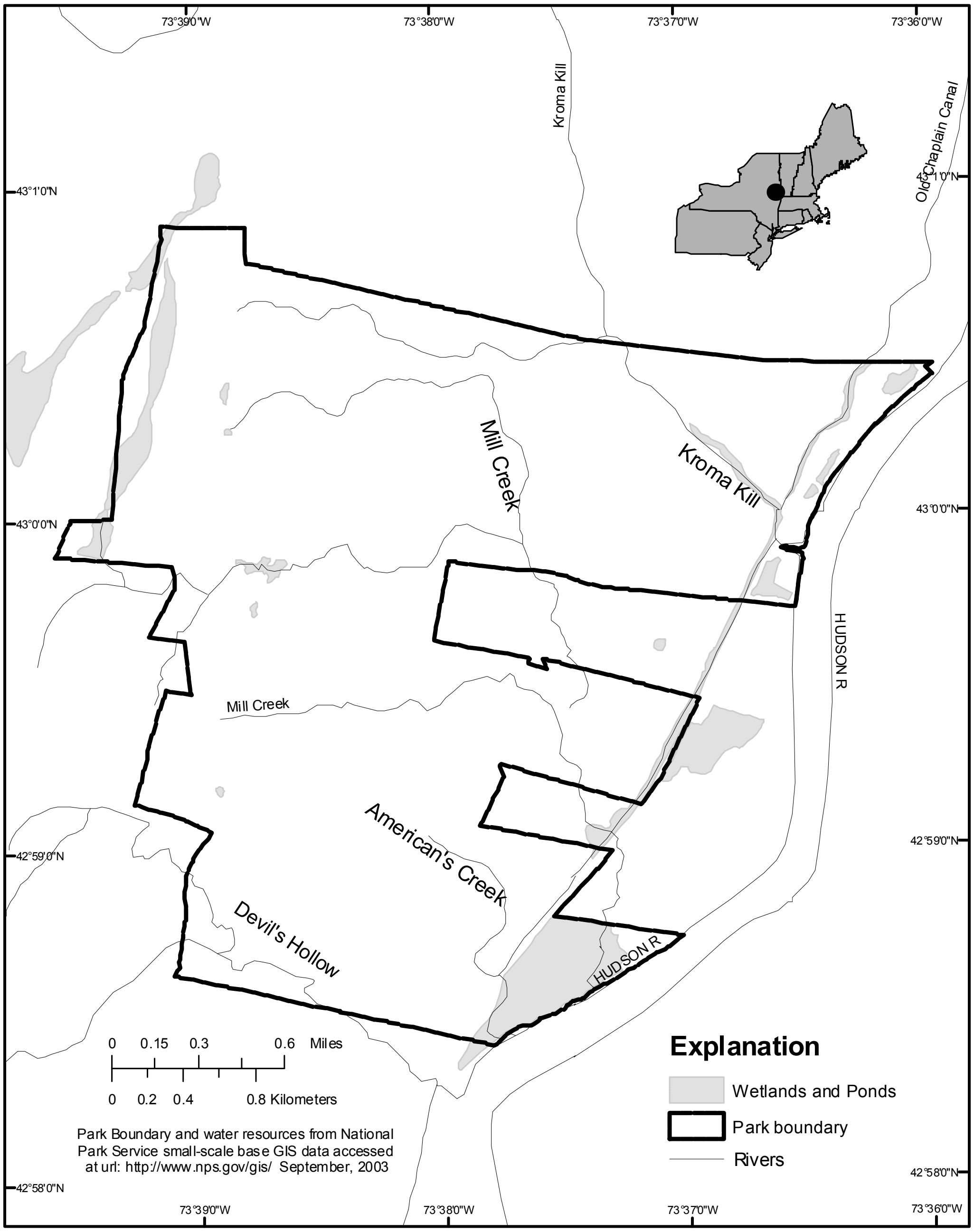

Figure 16. Freshwater resources at Saratoga National Historic Park, New York. [Note: Old Saratoga Unit not shown].

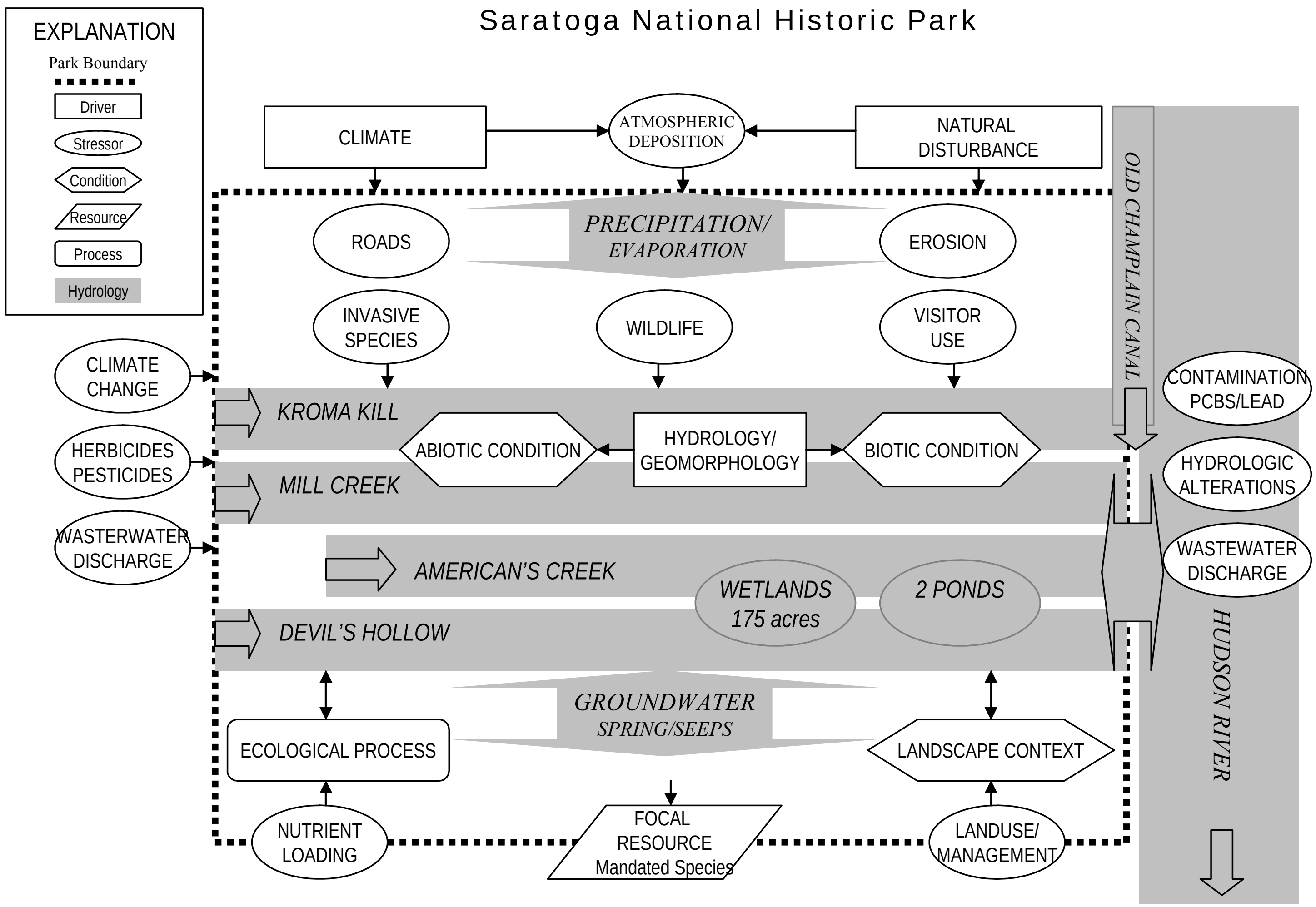

Figure 17. Conceptual model of freshwater ecosystems at Saratoga National Historic Park, New York. [Note: Old Saratoga Unit not represented].

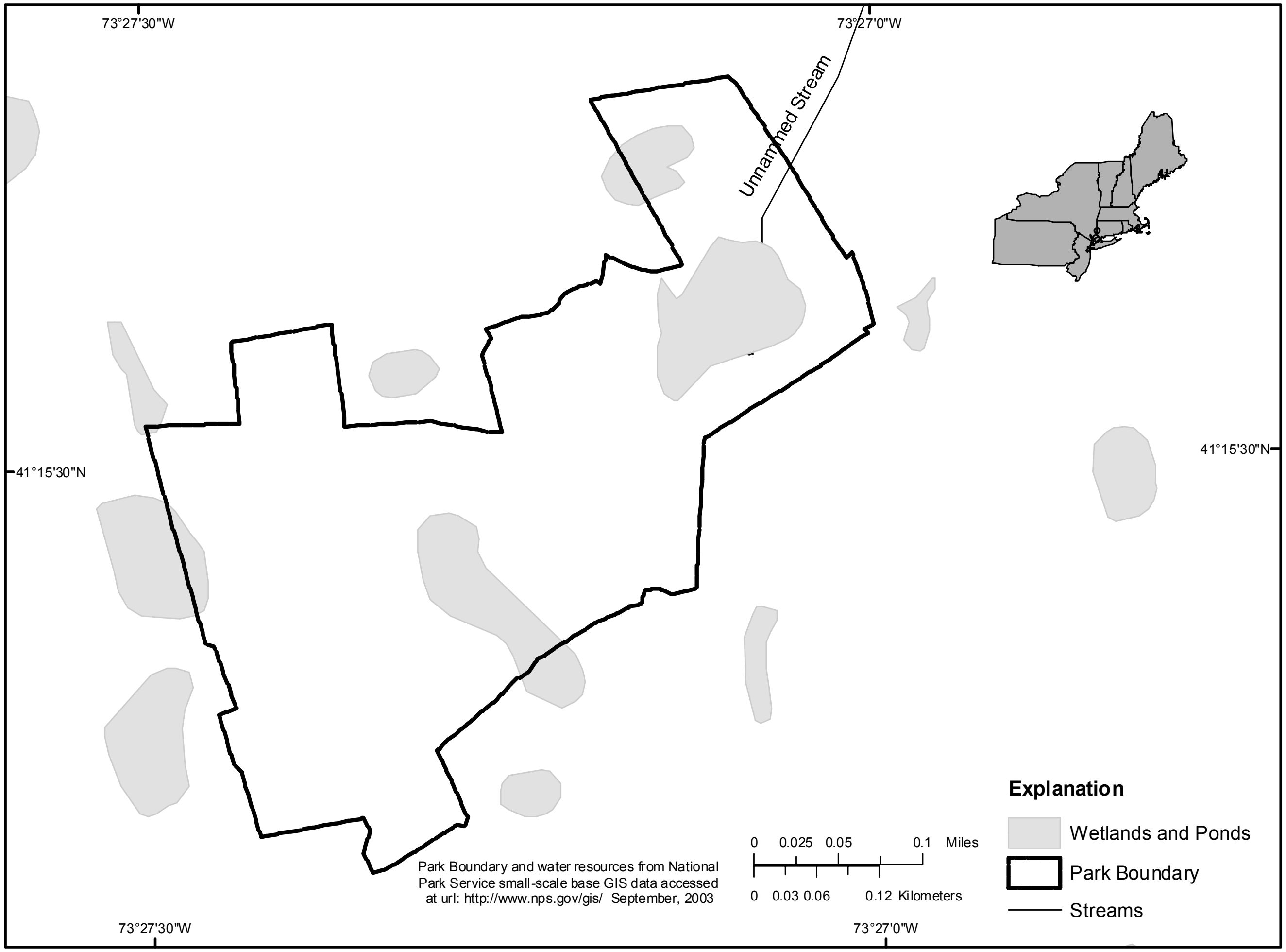

Figure 18. Freshwater resources at Weir Farm National Historic Site, Connecticut.

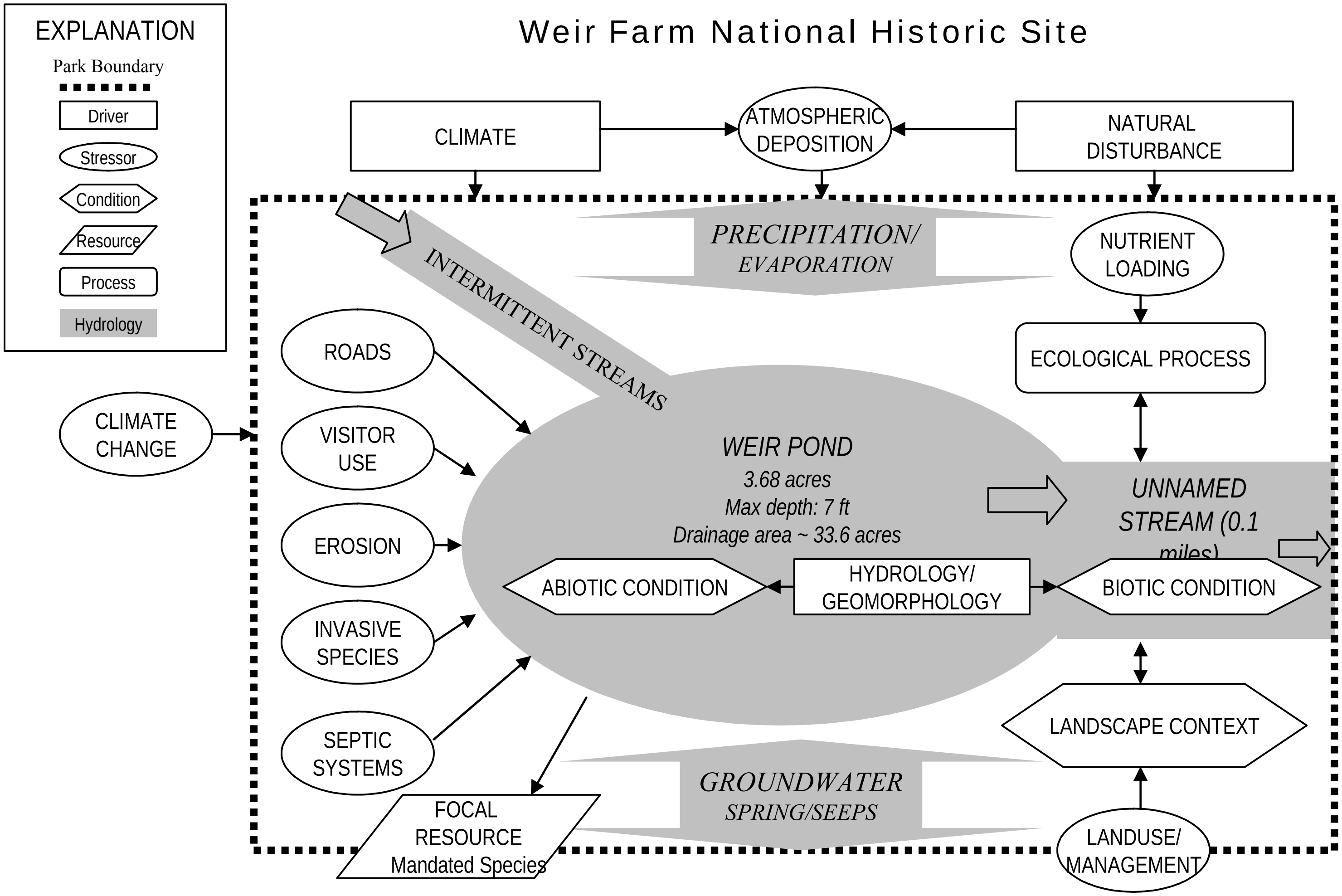

Figure 19. Conceptual model of freshwater ecosystems at Weir Farm National Historic Site, Connecticut.

Table 2. Potential natural resource threats to parks in the Northeast Temperate Network as indicated by natural resource staff [0, not a threat; 1, low threat; 2, high threat with present management concern].

STRESSORS	ACAD	BOHA	MABI	MIMA	MORR	ROVA	SAGA	SAIR	SARA	WEFA
Climate change										
Temperature change	1	1	1	1	1	1	1	1	1	1
Precipitation change	1	1	1	1	1	1	1	1	1	1
Atmospheric deposition										
Acid rain	2	2	2	2	2	2	2	2	2	2
External development										
Road runoff	2	0	1	2	2	2	2	2	2	1
Septic systems	2	0	0	2	2	2	2	2	2	1
Water withdrawals	2	0	0	2	2	2	2	2	2	0
Hydrologic alterations	1	0	0	1	0	1	0	2	2	0
Lawn chemicals	1	0	0	2	2	2	2	2	2	1
Wastewater treatment	1	0	0	2	2	2	2	2	2	0
Visitor use and park management										
Boats	1	0	0	1	0	0	0	0	1	0
Fishing	2	0	0	0	0	0	1	0	0	1
Roads/cars	2	0	2	2	2	2	2	2	2	2
Soil erosion	1	1	2	2	2	2	2	2	2	2
Forest harvest	0	0	2	0	1	0	1	0	0	0
Septic systems	1	1	1	1	1	1	1	1	1	2
Agriculture										
Nutrient loading	2	0	1	1	1	1	2	1	1	1
Irrigation	0	0	1	1	1	1	1	1	1	1
Agricultural chemicals	0	0	1	1	1	1	1	1	1	1
Livestock	0	0	1	1	1	1	1	1	2	1
Industry										
Water withdrawals	0	0	0	1	0	1	0	1	0	0
Contaminants	0	0	0	2	0	1	0	1	2	0
Invasive species										
Aquatic vegetation	2	2	2	2	2	2	2	2	2	2
Exotic fish	2	1	1	1	1	1	1	1	1	1
Wildlife										
Beaver activity	1	0	1	2	0	1	0	0	1	0

APPENDIXES

Appendix 1. USGS surface-water-discharge gaging stations and ground-water wells in Acadia National Park.

Appendix 2. USGS surface-water-discharge gaging stations and ground-water wells in all Northeast Temperate Network National Historical Parks, except Acadia.

Appendix 3. Summary of 305(b) Reports and 303(d) lists for freshwater bodies in or near Northeast Temperate Network National Parks.

Appendix 4. Freshwater body area statistics based on park Geographic Information Systems coverages and previously published information.

Appendix 1. USGS surface-water-discharge gaging stations and ground-water wells in and around Acadia National Park. [Data and site information for the above listed stations can be obtained at the following URL: http://waterdata.usgs.gov/nwis/inventory; DA, drainage area; SW, surface water; QW, water quality; GW, ground water; mi^2, square miles; Q, discharge.]

Station Name	Station Number	Latitude Longitude	Station Type	DA (mi^2)	In Park?	Data Type	Continuous/ Intermittent	Period of Record
Old Mill Brook at Old Norway Drive near Bar Harbor, Maine	01022800	44°23'55" 68°17'14"	SW QW	1.55	No	Daily Q QW	C I	4/99-9/00 2/99-9/00
Cadillac Brook near Bar Harbor, Maine	01022835	44°20'41" 68°13'02"	SW	0.12	Yes	Daily Q	C	5/99-1/04
Hadlock Brook nr Cedar Swamp Mtn near Northeast Harbor, Maine	01022860	44°19'54" 68°16'48"	SW	0.18	Yes	Daily Q	C	4/99-1/04
Old Mill Brook below Crooked Road near Bar Harbor, Maine	01022805	44°24'52" 68°17'44"	SW	2.42	Yes	Q QW	I I	4/99-9/00 "
Stony Brook below Hamilton Pond near Bar Harbor, Maine	01022810	44°25'28" 68°17'30"	SW	2.66	No	Q QW	I I	4/99-8/00 "
Aunt Betsey's Brook near Bar Harbor, Maine	01022815	44°24'22" 68°19'10"	SW	0.63	No	Q QW	I I	4/99-9/00 "
French Hill Brook near Bar Harbor, Maine	01022817	44°24'23" 68°18'44"	SW	0.56	No	Q QW	I I	4/99-9/00 "
Breakneck Brook near Bar Harbor, Maine	01022825	44°24'43" 68°15'05"	SW	1.46	Yes	Q QW	I I	2/99-9/00 "
Otter Creek near Bar Harbor, Maine	01022840	44°19'58" 68°12'26"	SW	1.35	Yes	Q QW	I I	2/99-9/00 "
Hunters Brook near Seal Harbor, Maine	01022845	44°18'34" 68°13'20"	SW	1.37	Yes	Q QW	I I	2/99-9/00 "
Stanley Brook near Seal Harbor, Maine	01022850	44°18'20" 68°14'30"	SW	1.36	No	Q QW	I I	1/99-9/00 "
Hadlock Brook at Sargent Drive at Northeast Harbor, Maine	01022865	44°18'08" 68°17'58"	SW	0.18	No	Q QW	I I	2/99-9/00 "
Kitteredge Brook near Bar Harbor, Maine	01022875	44°22'46" 68°19'52"	SW	2.84	No	Q QW	I I	1/99-2/00 "
Man of War Brook near Southwest Harbor, Maine	01022880	44°19'06" 68°19'01"	SW	0.32	Yes	Q QW	I I	1/99-9/00 "
Marshall Brook near Southwest Harbor, Maine	01022890	44°16'29" 68°21'06"	SW	1.97	Yes	Q QW	I I	2/99-9/00 "

Appendix 1. (cont.)

Station Name	Station Number	Latitude Longitude	Station Type	DA (mi^2)	In Park?	Data Type	Continuous/ Intermittent	Period of Record
Heath Brook near Tremont, Maine	01022895	44°16'40" 68°22'06"	SW	0.91	yes	Q QW	I I	2/99-9/00 "
Marshall Brook below Seal Cove Road near Southwest Harbor, Maine	441604068205701	44°16'04" 68°20'57"	SW	un-known	yes	QW	I	9/79-10/79
Marshall Brook Tributary at Seal Cove Rd nr Southwest Harbor, Maine	441702068210201	44°17'02" 68°21'02"	SW	un-known	yes	QW	I	9/79-10/79
Marshall Brook at Seal Cove Road near Southwest Harbor, Maine	441706068204701	44°17'06" 68°20'47"	SW	un-known	yes	QW	I	9/79-10/79
Marshall Brook Tributary at Mt Rd near Southwest Harbor, Maine	441734068214301	44°17'34" 68°21'43"	SW	un-known	yes	QW	I	9/79-10/79
Marshall Brook at Mt Rd near Southwest Harbor, Maine	441746068213001	44°17'46" 68°21'30"	SW	un-known	yes	QW	I	9/79-10/79
HW 137	441440068182701	44°14'40" 68°18'27"	GW	NA	yes	GW levels QW	I I	6/81-8/00 5/1985
ME-HW-173 Hio Hill near Southwest Harbor, Maine	441516068194101	44°15'16" 68°19'41"	GW	NA	yes	GW levels QW	C I	8/03-1/04 in progress
Me-HW-174 Seal Cove Road near Southwest Harbor, Maine	441650068210801	44°16'50" 68°21'08"	GW	NA	yes	GW levels QW	C I	10/03-1/04
HW 135A	44191068112101	44°19'19" 68°11'21"	GW	NA	yes	QW	I	1 day (7/27/1967)
HW 135B	442000068105501	44°20'00" 68°10'55"	GW	NA	yes	QW	I	1 day (7/27/1967)
HW 136	442102068134801	44°21'02" 68°13'48"	GW	NA	yes	QW	I	1 day (7/26/1967)
ME-HW-171 McFarland Hill near Bar Harbor, Maine	442238068154101	44°22'38" 68°15'41"	GW	NA	yes	GW levels QW	C I	8/03-1/04 in progress

Appendix 1 (cont.)

Station Name	Station Number	Latitude Longitude	Station Type	DA (mi^2)	In Park?	Data Type	Continuous/ Intermittent	Period of Record
ME-HW 170 (domestic well)	442405068165801	44°24'05" 68°16'58"	GW	NA	No	GW levels	I	1 day (12/21/1999)
ME-HW 168 (domestic well)	442408068194101	44°24'08" 68°19'41"	GW	NA	No	GW levels	I	1 day (12/21/1999
ME-HW 165 (domestic well)	442418068180701	44°24'18" 68°18'07"	GW	NA	No	GW levels	I	1 day (12/21/1999)
ME-HW 166 (domestic well)	442426068181901	44°24'26" 68°18'19"	GW	NA	No	GW levels	I	1 day (12/21/1999
ME-HW 169 (domestic well)	442436068201801	44°24'36" 68°20'18"	GW	NA	No	GW levels	I	1 day (12/21/1999
ME-HW 167 (domestic well)	442438068175201	44°24'38" 68°17'52"	GW	NA	No	GW levels	I	1 day (12/21/1999
ME-HW-172 Crooked Road near Bar Harbor, Maine	442450068175201	44°24'50" 68°17'52"	GW	NA	No	GW levels QW	C I	8/03-1/04 in progress
Northeast Creek at Rt 3 Bridge near Bar Harbor, Maine	01022820	44°25'29" 68°19'36"	Estuary	NA	No	Q QW	C C	5/31/2000- 11/28/2001
Northeast Creek monitoring station 103	442507068185301	44°25'07" 68°18'53"	Estuary	NA	No	QW	C	5/31/2000- 11/28/2001
Northeast Creek monitoring station 104	442509068181901	44°25'09" 68°18'19"	Estuary	NA	No	QW	C	5/31/2000- 11/28/2001
Northeast Creek monitoring station 105	442516068175501	44°25'16" 68°17'56"	Estuary	NA	No	QW	C	5/31/2000- 11/28/2001
Northeast Creek monitoring station 102	442517068190501	44°25'18" 68°19'05"	Estuary	NA	No	QW	C	5/31/2000- 11/28/2001
Northeast Creek monitoring station 100	442530068193901	44°25'30" 68°19'40"	Estuary	NA	No	QW	I	5/31/2000- 11/28/2001

Appendix 2. USGS surface-water-discharge gaging stations and ground-water wells in and around Northeast Temperate Network National Historical Parks.

[ACAD stations are in Appendix 1 only; Stations in bold text are most representative continuous-record streamflow gaging-station for the national park for which it is listed, and which is currently in operation; Data and site information for the above listed stations can be obtained at the following URL: http://waterdata.usgs.gov/nwis/inventory. DA, drainage area; SW, surface water; QW, water quality; GW, ground water; mi^2, square miles; Q, discharge; NA, not applicable/not available.]

Park	Station Name	Station Number	Latitude Longitude	DA (mi^2)	Years of Record	Data Type	In Park?	*Remarks*
MABI	**Ottauquechee River at North Hartland, Vermont**	**01151500**	**43°36'09" 72°21'17"**	**221**	**1927-2001 1930-2002 1954-1999**	**Peak Q Daily Q QW**	**No**	
	Ottauquechee River at Woodstock, Vermont	01151000	43°37'29" 72°31'14"	126	1927-1930 1928-1930	Peak Q Daily Q	No	
	VT-X8W 14	433740072305801	43°37'41" 72°30'57"	NA	1994	GW QW		
MIMA	**Concord River below Meadow Brook at Lowell, Massachusetts**	**01099500**	**42°38'12" 71°18'09"**	**400**	**1938-2001 1936-2002 1952-1994**	**Peak Q Daily Q QW**	**No**	
MORR	**Passaic River near Millington, New Jersey**	**01379000**	**40˚40'48" 74˚31'44"**	**55.4**	**1904-2002 1903-2002 1923-1998**	**Peak Q Daily Q QW**	**No**	**Real-time site**
	Passaic River near Bernardsville, New Jersey	01378690	40°44'03" 74°32'25"	8.83	1968-2001 1967-1976 1965-1979	Peak Q Daily Q QW	No	Not currently active
	Primrose Brook in Morristown National Historic Park, New Jersey	01378780	40°45'54" 74°31'47"	1.07	1997-2001	QW	Yes	
	WB Primrose Brook in Morristown National Historic Park, New Jersey	01378775	40°46'11" 74°32'10"	NA	0	QW	Yes	New station in 2003; no data yet
	EB Primrose Brook in Morristown National Historic Park, New Jersey	01378778	40°46'14" 74°31'26"	NA	0	QW	Yes	New station in 2003; no data yet

Appendix 2. (cont.)

Park	Station Name	Station Number	Latitude Longitude	DA (mi^2)	Years of Record	Data Type	In Park?	*Remarks*
ROVA	**Rondout Creek at Rosendale, New York**	**01367500**	**41˚50'35" 74˚05'11"**	**383**	**1902-2002 1901-2002 1962-1994**	**Peak Q Daily Q QW**	**No**	**Real-time site**
	Wappinger Creek near Wappingers Falls, New York	**01372500**	**41˚39'11" 73˚52'23"**	**181**	**1929-2002 1928-2002 1959-1994**	**Peak Q Daily Q QW**	**No**	**Real-time site**
	Crum Elbow Creek at Hyde Park, New York	01372040	41°47'24" 73°55'53"	17.3	1960-1976 1960-1962 1966	Peak Q Daily Q QW	No	Not currently active
	Fall Kill at Poughkeepsie, New York	01372051	41°42'36" 73°55'36"	18.8	1994-1995 1993-1995 1993-1995	Peak Q Daily Q QW	No	
	Crum Elbow Creek near Hyde Park, New York	0137203960	41°48'00" 73°54'52"	16.5	1992	QW	No	
	Hyde Park Fire & WD-Crum Elbow Creek 1843D	414729073555700	41°47'29" 73°55'57"	NA	1971; 1 day	QW		1 round of sampling
	Hyde Park Fire &WD WTP-Crum Elbow Creek 1843T	414730073555600	41°47'30" 73°55'56"	NA	1975; 1 day	QW		1 round of sampling
	Hyde Park Fire & WD WTP-Crum Elbow Creek 1843T	414730073555601	41°47'30" 73°55'56"	NA	1975; 1 day	QW		1 round of sampling
SAGA	**Sugar River at West Claremont, New Hampshire**	**01152500**	**43°23'15" 72°12'45"**	**269**	**1929-2001 1928-2002 1953-1999**	**Peak Q Daily Q QW**	**No**	
	Ottauquechee River at North Hartland, Vermont	**01151500**	**43°36'09" 72°21'17"**	**221**	**1927-2001 1930-2002 1954-1999**	**Peak Q Daily Q QW**	**No**	
	Blow-Me-Down Brook near Plainfield, New Hampshire	01151610	43°30'09" 72°22'20"	unknown	1 day	QW	No	1 round of sampling
SAIR	**Saugus River at Saugus Iron Works at Saugus, Massachusetts**	**01102345**	**42°28'10" 71°00'27"**	**20.8**	**1994-2000 1994-2002 1994-2001**	**Peak Q Daily Q QW**	**No**	

Appendix 2. (cont.)

Park	Station Name	Station Number	Latitude Longitude	DA (mi^2)	Years of Record	Data Type	In Park?	*Remarks*
SARA	**Hudson River at Stillwater, New York**	**01331095**	**42˚56'08" 73˚39'08"**	**3,773**	**1913-2002 1977-2002 1969-2002**	**Peak Q Daily Q QW**	**No**	
	Mohawk River Diversion at Crescent Dam, New York	**01357499**	**42˚48'10" 73˚42'11"**	**NA**	**1925-2002**	**Daily Q**	**No**	
	Saratoga National Park, SA-1072	430013073370401	43°01'13" 73°37'04"	224 ft	1959-1995	GW levels	Yes	
WEFA	**Norwalk River at South Wilton, Connecticut**	**01209700**	**41°09'49" 73°25'11"**	**30**	**1955-2002 1962-2002 1962-2002**	**Peak Q Daily Q QW**	**No**	

Appendix 3. Summary of 305(b) Reports and 303(d) lists for freshwater bodies in or near Northeast Temperate Network National Parks. [Parks listed in alphabetical order; waterbodies listed in **bold text** are within the park boundaries; waterbodies listed in plain text are adjacent to or near park boundaries.]

Acadia National Park (ACAD)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	**Impairments**	**List ID**	**Reason**	**TMDL[3]**
All rivers and lakes	not available	not available	ME9985_LR	FCA Mercury	none
Long Pond	was on 303d list, but removed b/c attained QW standards		not available	not available	none
Mt Desert coastal lakes	not available	not available	not available	not available	none
Mt Desert coastal rivers	514R	attaining some, insuff. data for other uses	not available	not available	none
Tinker Brook- West Tremont	707-11	insuff. data to determine attainment	not available	not available	none

[1] http://oaspub.epa.gov/waters/state_rept.control?p_state=ME (electronic copy not submitted to USEPA as of 11/03)
[1] http://www.state.me.us/dep/blwq/docmonitoring/305bappendix.pdf
[2] http://www.wcei.org/maine/me-contents.html
[3] http://oaspub.epa.gov/waters/state_rept.control?p_state=ME
Further state information can be obtained at dave.l.courtemanch@state.me.us

Boston Harbor Islands National Recreation Area (BOHA)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	**Impairments**	**List ID**	**Reason**	**TMDL[3]**
Ice Pond	not available	not available	MA74028	Pesticides	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=MA
[2] http://www.wcei.org/massachusetts/ma-contents.html
[3] http://oaspub.epa.gov/waters/region_rept.control?p_region=MA
Further state information can be obtained at **Richard.Mcvoy@state.ma.us**

Marsh-Billings-Rockefeller National Historical Park, Vermont (MABI)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	Impairments	List ID	Reason	TMDL[3]
All rivers and lakes	not available	not available	VT3526_LR-1998	FCA mercury	none
The Pogue Pond	not available	not available	not available	not available	none
Pogue Hole Brook	not available	not available	not available	not available	none

Appendix 3. (cont.)

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=VT
[2] http://www.wcei.org/vermont/vt-contents.html
[3] http://oaspub.epa.gov/waters/region_rept.control?p_region=VT
Further state information can be obtained at **http://www.anr.state.vt.us/dec/waterq/Planning/Assessment.2000.pdf**

Minute Man National Historic Park, Massachusetts (MIMA)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	Impairments	List ID	Reason	TMDL[3]
All rivers and lakes	n/a	n/a	MA4348_LR-1998	FCA mercury	none
Concord River	MA82A-07_00	metals, total toxics	MA82A-08_1998	metals, nutrients	none
			MA82A-07_1998	metals, nutrients, pathogens	
			MA82A-09_1998	nutrients, pathogens	
Elm Brook	MA83-05_00	nutrients, pathogens, turbidity	not available	not available	none
Mill Brook	MA42-10_00	not available	not available	not available	none
	MA41-07_00				

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=MA
[2] http://www.wcei.org/massachusetts/ma-contents.html
[3] http://oaspub.epa.gov/waters/region_rept.control?p_region=MA
Further state information can be obtained at **Richard.Mcvoy@state.ma.us**

Appendix 3. (cont.)

Morristown National Historic Park, New Jersey (MORR)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	Impairments	List ID	Reason	TMDL[3]
Primrose Brook	not available	not available	not available	not available	none
East Branch Primrose Brook	not available	not available	not available	not available	none
West Branch Primrose Brook	not available	not available	not available	not available	none
Jersey Brook	not available	not available	not available	not available	none
Great Swamp	not available	not available	not available	not available	none
Cat Swamp Pond	not available	not available	not available	not available	none
Indian Grave Brook	not available	not available	not available	not available	none
Passaic River	not available	not available	not available	not available	none
Ledell's Pond	not available	not available	not available	not available	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=NJ
[2] http://www.wcei.org/newjersey/nj-contents.html
[3] http://oaspub.epa.gov/waters/state_rept.control?p_state=NJ#WBTYPE
Further state information can be obtained at **http://www.state.nj.us/dep/dsr/watershed/305b/305b.htm**

Roosevelt-Vanderbilt National Historic Site, New York (ROVA)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	Impairments	List ID	Reason	TMDL[3]
Fall Kill Creek	not available	not available	not available	not available	none
Crum Elbow Creek	not available	not available	not available	not available	none
Meriches (Maritje) Kill	not available	not available	not available	not available	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=NY
[2] http://www.wcei.org/newyork/ny-contents.html
[3] http://oaspub.epa.gov/waters/region_rept.control?p_region=NY
Further state information can be obtained at **jamyers@gw.dec.state.ny.us**

Appendix 3. (cont.)

Saint-Gaudens National Historic Site, New Hampshire (SAGA)

Waterbody	305(b) Assessment Information[1] Unit ID	Impairments	303(d) Information[2] List ID	Reason	TMDL[3]
Blow-Me-Down Brook	not available	not available	not available	not available	none
Blow-Me-Up Brook	not available	not available	not available	not available	none
Blow-Me-Down Pond	not available	not available	not available	not available	none
Farm Pond	not available	not available	not available	not available	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=NH
[2] http://www.wcei.org/newhampshire/nh-contents.html
[3] http://oaspub.epa.gov/waters/state_rept.control?p_state=NH
Further state information can be obtained at **www.des.state.nh.us/wmb/wmbpubs.htm**

Saratoga National Historic Park, New York (SARA)

Waterbody	305(b) Assessment Information[1] Unit ID	Impairments	303(d) Information[2] List ID	Reason	TMDL[3]
Kroma Kill	not available	not available	not available	not available	none
Mill Creek	not available	not available	not available	not available	none
American's Creek	not available	not available	not available	not available	none
Devil's Hollow	not available	not available	not available	not available	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=NY
[2] http://www.wcei.org/newyork/ny-contents.html
[3] http://oaspub.epa.gov/waters/region_rept.control?p_region=NY
Further state information can be obtained at **jamyers@gw.dec.state.ny.us**

Saugus Iron Works National Historic Site, Massachusetts (SAIR)

Waterbody	305(b) Assessment Information[1] Unit ID	Impairments	303(d) Information[2] List ID	Reason	TMDL[3]
Saugus River	MA93-14_00	ID for estuary only; impairments n/a	MA93-13_1998	Pathogens	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=MA
[2] http://www.wcei.org/massachusetts/ma-contents.html
[3] http://oaspub.epa.gov/waters/region_rept.control?p_region=MA
Further state information can be obtained at **Richard.Mcvoy@state.ma.us**

Weir Farm National Historic Site, Connecticut (WEIR)

Waterbody	305(b) Assessment Information[1]		303(d) Information[2]		
	Unit ID	Impairments	List ID	Reason	TMDL[3]
All rivers and lakes	not available	not available	CT4015_LR-1998	FCA Mercury	none
Weir Pond	not available	not available	not available	not available	none

[1] http://oaspub.epa.gov/waters/w305b_report.state?p_state=CT#assessed_waters
[2] http://www.wcei.org/connecticut/ct-contents.html
[3] http://oaspub.epa.gov/waters/state_rept.control?p_state=CT#TPOL
Further state information can be obtained at **ernest.pizzuto@po.state.ct.us**

Appendix 4. Freshwater body area statistics based on park Geographic Information System coverages and previously published information.

	Great Ponds (greater than 10 acres)		Small Ponds (less than 10 acres)		Streams		Palustrine wetlands	**Source**
	number	acres	number	acres	number	miles	acres	
Acadia National Park	14	2,370	10	50	41	(less than 2-3 miles each)	2,590	**Kahl and others, 2000 Cowardin and others, 1979**
Boston Harbor Island National Recreation Area	0	0	1	*	0	0	31	**Tiner and others, 2003**
Marsh-Billings-Rockefeller National Historical Park	1	15	0	0	1	0.9	5	**National Park Service, 2003f**
Minute Man National Historical Park	0	0	3	*	3	1.2	200	**National Park Service, 2003f**
Morristown National Historical Park	0	0	1	*	5	4.4	22	**National Park Service, 1993; National Park Service, 2003f**
Roosevelt-Vanderbilt National Historic Site	0	0	12	15	3	4.5	72	**National Park Service, 2003f**
Saint-Gaudens National Historic Site	0	0	2	5	2	1.6	18	**National Park Service, 2003f**
Saugus Iron Works National Historic Site	0	0	0	0	1	.15	5	**National Park Service, 2003f**
Saratoga National Historic Park	0	0	2	*	4	12.8	175	**National Park Service, 2003f**
Weir Farm National Historic Site	0	0	1	4	1	.06	2.5	**National Park Service, 2003f**

* Included in wetland acreage.